The Drivers of Demand for Ecological Sanitation & Barriers Affecting its Adoption in Low-income and High Population Density Urban Areas.

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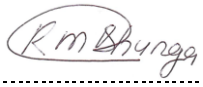
DECLARATION

I, Richard Chunga, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signed  Date: July 30, 2015

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Dedication

I dedicate this thesis to my parents, Bertha and David Chunga.

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ABSTRACT

This thesis examines sanitation technology choices of property owners, their attitude towards ecological sanitation (alternative sanitation technology) and local adaptation strategies they adopt where there is concern about space for replacing pit latrines. Data were collected from two cities in Malawi through mixed methods research which targeted 1,300 property owners from 27 low-income and high population density urban settlements. The results showed that nearly 100% of the property owners liked the concept of ecological sanitation because it offers users technologies that are designed to be emptied and reused (permanent facilities), less likely to collapse, safer for children to use and less smelly. However, only 13% had intention to adopt ecological sanitation but when microfinance for sanitation was offered, the proportion of property owners that had intention to adopt ecological sanitation increased to 32%. Ecological sanitation was perceived as unaffordable and potentially unworkable as a shared sanitation solution due to its small chamber size and the inconvenience of emptying its vaults and handling human excreta. Where there is concern about space for replacing pit latrines, property owners prefer to adapt by changing the way they build, operate and maintain pit latrines to adoption of ecological sanitation. Adaptation strategies property owners adopt are easier and cheaper to implement and are compatible with the way property owners and their tenants have traditionally been building, operating and maintaining sanitation facilities. The results suggest that as cities rapidly urbanise, property owners will prefer to address the limitations of pit latrines by improving the build quality of the pit latrines and changing the way they operate and maintain them to adoption of alternative sanitation technologies. To reach scale, alternative sanitation technologies should be affordable, easy to use, compatible with users from multiple households and compatible with the needs and practices of the target audience. However, without microfinance for sanitation, the promotion of alternative sanitation technologies will not significantly increase the proportion of urban residents gaining access to sustainable sanitation.

CHAPTER 1

THE NEED FOR SUSTAINABLE SANITATION SYSTEMS IN LOW-INCOME URBAN AREAS

Figure 1.1: Gulper for pit emptying.

Figure 1.2: Faecal sludge on latrine floor

Figure 1. 3: Twin pit fossa alterna with one hole in use and another one closed.

Figure 1. 4: Urine diverting toilet (UDT), with two holes that are used alternately.

1. Introduction

Globally, about 842 thousand people mostly children less than five years old die every year from diarrhoea caused by inadequate drinking water, inadequate sanitation[1] and inadequate hygiene (Prüss-Ustün et al., 2014). Inadequate sanitation alone accounts for nearly 280, 000 deaths annually and may contribute to serious health problems such as malnutrition and growth stunting (Dangour et al., 2013).

In the year 2000, governments globally agreed to reduce by half the proportion of people without access to improved sanitation[2] from 51% in 1990 to 25% by 2015. The Joint Monitoring Programme for water supply and sanitation (JMP) reports that between 1990 and 2012, 2 billion people gained access to improved sanitation and 77 countries managed to reduce by half the proportion of people without access to improved sanitation (WHO/UNICEF, 2014). Despite progress, nearly 2.5 billion people still do not have access to improved sanitation facilities and of these, 1 billion are still practicing open defecation (WHO/UNICEF, 2014).

While governments, international and local organisations and sanitation experts continue to seek solutions that will reduce open defecation and increase access to improved sanitation, another key challenge facing many city authorities in low-income countries is how to safely collect, treat and dispose wastewater and faecal sludge from waterborne and dry sanitation systems (Peal at el., 2014; Werner, 2009).

1.1 Conventional sanitation systems

Conventional sanitation systems can be classified as either waterborne e.g. flush toilets or dry e.g. pit latrines. The key difference is that dry sanitation systems do not need a network of pipes nor water to transport excreta to designated locations for treatment while waterborne systems require water and a network of pipes or vacuum tankers to transport wastewater to centralised wastewater treatment locations. The design of waterborne and dry sanitation systems is based on the premise that human

[1]Sanitation here refers to disposal of human excreta. Inadequate sanitation refers to sanitation facilities that do not hygienically separate human excreta from human contact.
[2] Sanitation facilities that hygienically separate human excreta from human contact.

excreta are waste that must be disposed and that the environment can assimilate this waste (Werner, 2009). However, in many cities in low-income countries, waterborne and dry sanitation systems are increasingly becoming unsustainable.

1.1.1 The limitations of waterborne sanitation systems

Waterborne sanitation systems are considered as improved sanitation systems. However, waterborne sanitation systems have several challenges that make them unsustainable. They have high capital, operational and maintenance costs and will need to be adapted to meet increasing pressures associated with rapid urbanisation (Haq & Cambridge, 2012; IWA, 2014). Furthermore, many city authorities in low-income countries do not have the resources to expand sewer networks to meet growing demand (Peal et al., 2014; Szanto et al., 2012). Werner et al (2009) summarised the disadvantages of waterborne sanitation as follows:

- Unsatisfactory purification or uncontrolled discharge of more than 90% of wastewater worldwide.
- Pollution of water bodies by nutrients, hazardous substances, pathogens, pharmaceutics, hormones, etc.
- Severe environmental damage and eutrophication of the water cycle.
- Consumption of precious water for transport of waste.
- Frequent subsidisation of prosperous areas and neglect of poor settlements.
- Loss of valuable nutrients and trace elements contained in excrement through their discharge into water bodies.

1.1.2 The limitations of pit latrines (dry sanitation system)

In low-income countries, pit latrines are the most common form of sanitation. Although pit latrines are common, they have several challenges. They are smelly, they attract flies and can contaminate ground water (Graham & Polizzotto, 2013; Langergraber, 2005). When pit latrines fill up, they must be replaced or emptied. However, space for replacing pit latrines may not always be available (Isunju et al., 2011). Where there is no space for replacing pit latrines, pit emptying is the only option available to urban residents (Thye et al., 2011). However, the task of emptying pit latrines and treating faecal sludge is very challenging.

Few cities across Africa have the management structures, institutional arrangements, infrastructure, skills, or financial systems to safely collect, treat and discharge human excreta from pit latrines (Peal et al., 2014). Faecal sludge management research carried out in 12 cities in Africa showed that faecal sludge from only 22% of households was properly treated (Hawkins et al., 2014). The poor design and structural problems associated with pit latrines, lack of access roads for vacuum tankers, lack of satisfactory pit emptying equipment and inadequate funding for faecal sludge treatment are key barriers preventing city authorities from collecting and treating faecal sludge (Jenkins et al., 2014; Murungi & van Dijk, 2014). In many countries, pit latrines are emptied manually and the contents discharged into water ways untreated, exposing many people to infection and disease (Peal et al., 2014) .

1.2 Sustainable sanitation

Considering the lack of space for replacing pit latrines, the difficulties of emptying pit latrines and the environmental pollution caused by the discharge of untreated faecal sludge into water ways; the key objective post millennium development goals is to support urban residents to gain access to sustainable sanitation. The main objective of sustainable sanitations to protect and promote human health by providing a clean environment and breaking the cycle of disease (Lüthi et al., 2011). To be sustainable, a sanitation system must be economically viable, socially acceptable, and technically and institutionally appropriate, while also protecting the environment and natural resources (Lüthi, et al., 2011).

In low-income and high population density urban areas, the development and promotion of alternative on-site sanitation technologies is seen as an important strategy for supporting urban residents to gain access to sustainable sanitation. One of the technologies that has been heavily promoted in several low-income countries in Southeastern Africa is ecological sanitation (Abraham et al., 2011; Jackson, 2005).

1.2.1 Ecological sanitation

Ecological sanitation presents a new approach in the operation and maintenance of sanitation facilities. A key feature of ecological sanitation is that it regards human

excreta as a resource to be recycled rather than waste to be disposed (Bracken, Münch, & Panesar, 2009; Langergraber, 2005). Depending on life style, eating habits and region, an individual can produce as much as 5.7 kg of nitrogen (N), 0.6 kg of phosphorus and 1.2 kg of potassium (K) annually and the amount of plant nutrients excreted by one person is believed to be sufficient to produce as much as 250 kg of grain per year (Haq & Cambridge, 2012).

Other than improving access to plant nutrients for crop production, ecological sanitation offers urban residents other benefits. First, ecological sanitation facilities offer urban residents and city authorities an opportunity to save money as they neither need water for flushing, nor pipelines to transport faecal sludge, nor treatment plants and arrangements for the disposal of faecal sludge (Meinzinger, 2009; Werner, 2009). Secondly, ecological sanitation facilities are considered to be ideal where space for replacing pit latrines is limited because they are designed to be emptied and put back into use (Jackson, 2005; Mugure, 2009). Ecological sanitation facilities are also considered to be ideal where pit latrines are difficult to construct, e.g. areas with high groundwater table or shallow bedrock (Abraham, et al., 2011).

Three main types of facilities fall under the umbrella of ecological sanitation: Arborloo, Fossa alterna and Urine diverting toilets. These technologies have been described by Morgan and Mekonnen (2013) as follows: an *arborloo* consists of a shallow pit usually 1 meter deep with a movable slab and superstructure. Soil and ash are added to the pit after each use and when nearly full, the slab and structure are moved to another shallow pit and a tree is planted on the filled pit. The Fossa alterna operates in a similar way to the Arborloo but has two shallow pits (1.5m deep) which are used alternately. When one pit is full, it is covered with soil and left to mature and the second pit is put to use. When the second pit is full, the contents of the first pit are emptied and the toilet reverts to the first pit. The removed pit contents are then stored in bags for later use or applied on gardens or trees. The third type, the Urine diverting toilet (UDT) has two shallow vaults built above ground level. Faeces are collected separately, using a urine-diverting pedestal or squat plate. The faeces (together with soil and/or ash) build up in a vault or bucket whilst the urine is collected in a suitable plastic reservoir.

1.2.1.1 Challenges associated with ecological sanitation

Although ecological sanitation offers users and city authorities several benefits, getting people to accept and use the technology has proven to be a big challenge (Abraham, et al., 2011; Rosenquist, 2005). Previous studies have identified several challenges associated with the technology. Firstly, the installation cost of ecological sanitation is considered to be too expensive for low-income households as they must purchase new materials and pay for skilled labour (Abraham, et al., 2011; Uddin et al.,2012). In contrast, pit latrines are cheaper since households use locally available materials and sometimes install pit latrines on their own (no need for skilled labour). Secondly, perceptions about disgust play an important role in the use of human excreta for agricultural production (Okem, 2013). In many cultures, faeces are perceived as disgusting and to many people, the thought of using faeces for food production is repulsive (Mariwah & Drangert, 2011; Winblad, 2000) However, research carried out in Kenya suggests that after several years, people tend to overcome cultural barriers and accept ecological sanitation (Uddin, et al., 2012). Thirdly, research has shown that operation and maintenance of ecological sanitation (adding dry matter, frequent emptying of vaults) is too involving when ecological sanitation facilities are shared among multiple households (Roma et al., 2013).

1.2.1.2 Microfinance and ecological sanitation

Studies about the adoption and diffusion of ecological sanitation have shown that affordability is a key barrier affecting the adoption of the technology (Abraham, et al., 2011; Uddin, et al., 2012). To support poorer households gain access to ecological sanitation, researchers have proposed improving access to microfinance[3] for sanitation (Uddin, et al., 2012). The advantage of microfinance is that payment for sanitation facilities is spread over a longer period and this has been shown to increase affordability among poorer households (Rosenboom, 2011; WSP, 2004). Reporting on the role of microfinance on increasing access to improved sanitation, Hadi (2000) observed that households involved with credit programmes were more likely to use safer sanitation facilities than others who were equally poor but not

[3] Provision of small loans to poor households without any collateral and who may not be able to access formal finance.

involved in such programmes. Although access to microfinance for sanitation has been identified as a key solution for increasing the adoption of ecological sanitation, there is no empirical evidence to suggest that improving access to microfinance for sanitation would significantly increase the adoption of ecological sanitation in low-income and high population density urban areas.

1.2.1.3 Safety of ecological sanitation

One of the key challenges of using ecological sanitation is achieving effective pathogen destruction in order that neither emptying the latrine nor using recycled human excreta in agriculture results in transmission of infections (Milburn et al., 2002; Moe, 2006). Of particular concern are soil-transmitted helminth infections which affect over 1.5 billion people worldwide (WHO, 2012). Soil-transmitted helminth infections are caused by different species of parasitic worms and are transmitted by eggs found in human faeces. Researchers have found viable helminth eggs in compost from human excreta (Endale et al., 2012; Mehl et al., 2011).

The risks of using human excreta as fertiliser arise when users do not add adequate dry matter (ash, soil or sawdust) into the vaults that collect faecal matter and when they fail to close their facilities and wait for 6 to 12 months before emptying them (Jensen et al., 2010; Mehl, et al., 2011). Commenting on the promotion of ecological sanitation, Bhagwan (2008) reported that sometimes facilities fill up much faster than expected and that the drying of faeces is not always optimum.

1.2.1.4 Summary

Although previous studies have offered useful insights about ecological sanitation, information from previous studies may not be very useful in guiding city wide sanitation policies or the design and development of alternative sanitation technologies for low-income and high population density urban areas. Key weaknesses of previous studies is that researchers either used socioeconomic characteristics of households as indicators of demand for the technology or they interviewed households that had already adopted the technology or they did not base their research on the theories of behaviour change and adoption of innovation. To

understand factors affecting the adoption of an innovation, it is important to evaluate the attitude of non adopters towards the innovation and their adoption intentions as adopters are likely to have positive views even if they did not have positive views before they adopted the innovation/technology under investigation (Tornatzky & Klein, 1982). To guide the development and promotion of appropriate alternative sanitation technologies, and strategies that would support urban residents to gain access to sustainable sanitation, it is important that policy makers and change agents understand the attitude of property owners towards ecological sanitation, their adoption intentions and the socioeconomic, demographic characteristics of property owners that are likely to accept or reject the technology.

1.2.2 Hygienic pit emptying services

Other than developing and promoting alternative sanitation technologies such as ecological sanitation, the development and promotion of hygienic pit emptying services is also seen as important strategy for reducing environmental pollution caused by the disposal of untreated human excreta into water ways (IWA, 2014; Radford & Fenner, 2013; Thye et al., 2011).

Several pit emptying technologies (e.g. Gulper, MAPET and vacutung) have been introduced in parts of Africa to support urban residents to maintain access to sanitation and help reduce environmental pollution from pit latrines (Thye et al., 2011). A key challenge with these technologies is that they are expensive for local entrepreneurs and they are not able to empty thick sludge or empty beyond 2 meters of pit latrines (Thye et al., 2011). Nevertheless, the promotion of hygienic pit emptying services and ecological sanitation offers property owners and their tenants two important competing strategies for gaining access to sustainable sanitation.

To guide urban sanitation policies, strategies and long term investment plans, it is important that policy makers and sanitation managers understand the choices property owners are likely to make when offered a range of options including pit latrines, ecological sanitation and a hygienic pit emptying service. Little is known about the choices of property owners in low-income and high population density urban areas. The choices property owners make have important implications on the

nature of pit emptying services that urban residents will demand. With ecological sanitation, users start the process of faecal sludge treatment (primary processing) by adding ash and soil into the vaults that collect faecal matter. Ecological sanitation facilities are emptied using hoes and shovels hence manually operated pit emptying equipment e.g. gulper, MAPET are not required. Pit latrines on the other hand require special pit emptying equipment.

1.2.3 What about local adaptation strategies?

The development and promotion of ecological sanitation and hygienic pit emptying services are seen as important strategies for supporting property owners and their tenants to gain access to sustainable sanitation. However, there is little discussion within the sanitation sector regarding local adaptation strategies that property owners implement to address the limitations of pit latrines, particularly lack of space for their replacement. Do they seek to adopt ecological sanitation or adapt pit latrines to cope? The strategies that property owners adopt where there is concern about space for replacing pit latrines have important implications on demand for ecological sanitation and pit emptying services. Commenting about successful sanitation marketing, Cairncross (2004) explained that it is important that change agents understand what people do to address their needs and how much they are willing to pay for sanitation products and services they want, not products that engineers and change agents think people should have.

Research has shown that when there is an environmental threat to individual wellbeing, individuals are likely to see the need for change and can and do adapt to their changing environmental circumstances based on their knowledge, expertise and resources (Nelson et al., 2007; Smithers & Smit, 1997). It is therefore recommended that strategies that aim at supporting individuals to respond to changing environmental conditions should be based on local knowledge and local adaptation strategies to be successful (Eriksen et al., 2011; McGuire & Sperling, 2008). Failure to understand local adaptation strategies leads to a one size fits all type of intervention which often fail to make significant impact (McGuire & Sperling, 2008).

1.3 Research gaps

This thesis addresses 4 research gaps: (1) In low-income and high population density urban areas, residents have a range of sanitation options including: adopting ecological sanitation, emptying their current pit latrine, constructing new pit latrines or pour flush toilets or septic tank toilets. However, there is little knowledge about the sanitation technology choices that property owners make or are likely to make when faced with a range of sanitation technology options. This information is important for planning urban sanitation services. (2) There is limited information about the attributes of alternative sanitation technologies that property owners are looking for. The perception and attitude of property owners towards ecological sanitation will offer useful information about the design of alternative sanitation technologies that property owners are looking for. (3) Affordability is frequently mentioned as a key barrier preventing urban residents from adopting ecological sanitation. Sanitation researchers have recommended improving access to microfinance for sanitation as a solution. However, there no empirical evidence to suggest that improving access to microfinance for sanitation would significantly improve the adoption of ecological sanitation. Information about the effect of microfinance for sanitation on demand for ecological sanitation and other alternative sanitation technologies is important for guiding urban sanitation policies and strategies for supporting urban residents to gain access to sustainable sanitation. (4) In rapidly urbanising settlements, space for replacing pit latrines may not always be available. However, there is limited knowledge about adaptation strategies property owners adopt where there is concern about space for replacing pit latrines. There is also little discussion about the implications of local adaptation strategies on demand for ecological sanitation, other alternative sanitation technologies and pit emptying services. Local adaptation strategies property owners adopt where there is concern about space for replacing pit latrines have important implications on the design and promotion of alternative sanitation technologies and pit emptying services.

1.4 Aims and objectives

This thesis sets out to examine the reasons why the adoption of ecological sanitation in low-income and high population density urban areas has been very slow and the local adaptation strategies property owners adopt to address the limitations of pit latrines, particularly lack of space for replacing pit latrines. Specifically, the thesis sets out to examine the following:

1. Sanitation technology choices that property owners make or are likely to make when faced with a range of options including: septic tank and pour flush toilets, ecological sanitation (Urine diverting & Fossa alterna), lined pit latrines, pit latrine with slab/cement floor, unimproved sanitation and a pit emptying service.

2. Socioeconomic and demographic indicators of demand for ecological sanitation (Urine diverting toilets and Fossa alterna toilets).

3. The effect of improving access to microfinance for sanitation on demand for Urine diverting toilets and Fossa alterna toilets (ecological sanitation).

4. The effect of increasing pit emptying service fees on demand for ecological sanitation and pit emptying services.

5. The extent of the problem of availability of space for replacing pit latrines and whether property owners seek to adopt ecological sanitation or adapt pit latrines to cope where there is concern about space for replacing pit latrines.

6. The perception and attitude of property owners towards ecological sanitation, the drivers of demand for the technology and barriers affecting its adoption.

1.5 Study site

The research was carried out in Lilongwe and Blantyre City in Malawi, Southeastern Africa. The National Statistics Office (NSO) reports that in 2008, Lilongwe City had a population of 669,021 people, an annual population growth rate of 4.3% and a population density of 1,479 persons per square kilometre while Blantyre City had a population of 661,444 people, an annual population growth rate of 2.8% and a population density of 3,006 persons per square kilometre (NSO, 2008). Over 70% of urban residents in the two cities reside in low-income and high population density areas (UN-HABITAT, 2011a, 2011b) and about 26% of urban residents live below the poverty line while 6.9% are classified as ultra poor[4] (NSO, 2011).

In these settings, the majority of residents are tenants who depend on sanitary facilities provided by their landlords. Hence, the quality, type and number of sanitation facilities available to tenants depends on the willingness of landlords to invest in sanitation (Isunju, et al., 2011). Tenants have a limited mandate to select the type and quality of sanitation facilities that landlords should offer and they may not demand sanitation improvements or be willing to pay for sanitation improvements due to their transient nature (Isunju, et al., 2011).

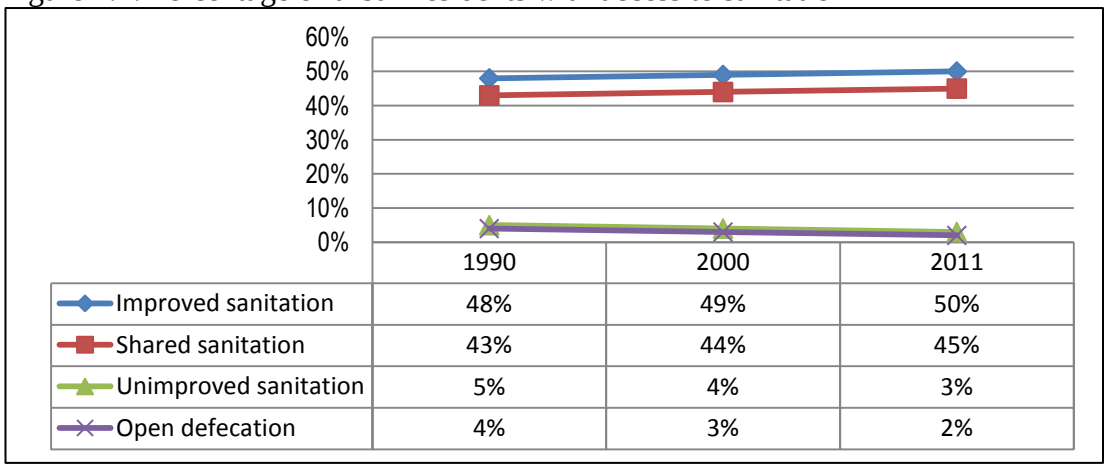
To increase access to improved sanitation, the government through the Ministry of Irrigation and Water Development (MIWD) adopted sanitation marketing approach in 2008/09. The sanitation marketing approach centres on promoting a range of sanitation products and services that consumers want and are willing to pay for. With this approach, urban residents pay the full cost of sanitation products and services but their promotion is carried out by both local and international non-governmental organisations with financial and technical support from the government and donors. A range of marketing techniques are used to promote sanitation. The most common techniques include: road shows, leaflets, community meetings and door to door visits. The door to door visits are carried out by hygiene promoters[5] and builders.

[4] Poor individuals are those whose total per capita consumption is below MK85, 852 and ultra poor individuals are those whose total per capita consumption is less than MK53, 262. 1US Dollar = 450 Malawi Kwacha (MK) at the time of the study.

[5] Hygiene promoters are volunteers recruited by non-governmental organisations to promote hygiene. They are usually property owners but tenants can also be recruited as hygiene promoters

Access to sanitation in urban areas in Malawi is high, with 50% estimated to be using improved sanitation, 45% using shared sanitation, 3% using unimproved sanitation[6] and 2% practising open defecation (WHO/UNICEF, 2014). While open defecation is very low, access to improved sanitation has hardly changed since 1990 (figure 1.4).

Figure 1.4: Percentage of urban residents with access to sanitation



	1990	2000	2011
Improved sanitation	48%	49%	50%
Shared sanitation	43%	44%	45%
Unimproved sanitation	5%	4%	3%
Open defecation	4%	3%	2%

Source of: (UNICEF-WHO, 2013)

Non-governmental organisations introduced ecological sanitation in the country in 2000/2001. Ecological sanitation was introduced to support urban residents to gain access to cheap fertiliser from recycled human excreta and also as a solution where space for replacing pit latrines is limited. Urine diverting toilets are promoted mainly in urban areas while Fossa alterna toilets are mainly promoted in rural areas. The adoption of ecological sanitation in urban areas has been very slow. The social welfare monitoring survey conducted by the National Statistics Office in 2011 showed that only 0.2% of urban residents had access to ecological sanitation (NSO, 2011). At the time of data collection, there were about 4,000 Urine diverting toilets in the two cities (CCODE - verbal communication)[7].

The average pit latrine life is estimated to be 3.9 years (MIWD, 2008). However, hygienic pit emptying services in low-income and high population density urban areas are almost non-existent. At the time of the study, WaterAid and Water for People (international non - governmental organisations) were supporting local entrepreneurs to empty pit latrines using gulpers (manually operated pit emptying

[6] Pit latrines with mud floor also identified as pit latrines without slab/cement floor
[7] CCODE, Centre for Community Organisation and Development is a local organisation that was focusing on ecological sanitation (Urine diverting toilets) in low-income urban areas.

equipment). There were two individuals emptying pit latrines with gulpers in Blantyre City and one individual in Lilongwe City. Faecal sludge was being emptied into 200 litre drums and transported to wastewater treatment stations on pick-up trucks but it was common for pit emptiers to also bury faecal sludge on site.

The structure of the thesis

The thesis has eight chapters. Chapter two presents a brief background about behavioural change theories, technology acceptance and innovation adoption theories. The chapter also discusses strategies that are useful when investigating technology choices. The aim of chapter three is to examine socioeconomic, demographic indicators of demand for ecological sanitation and the effect of microfinance for sanitation on sanitation technology choices. Chapter four examines the extent of the problem of space for replacing pit latrines and whether concern about space for replacing pit latrines is associated with intention to adopt ecological sanitation. Chapter five is an extension of chapter four. It examines local adaptation strategies property owners implement where there is concern about space for replacing pit latrines. The chapter explains the implications of local adaptation strategies on demand for ecological sanitation and pit emptying services. Chapter six examines the reasons property owners may prefer to empty their pit latrines over adoption of ecological sanitation or construction of new pit latrines. The chapter also examines the effect of increasing pit emptying service fees on demand ecological sanitation and pit emptying. Chapter seven explores the perceptions and attitude of property owners towards ecological sanitation and examines attitudes that are positively or negatively associated with intention to adopt the technology. The chapter identifies sanitation technology attributes that change agents should pay attention to when developing and promoting alternative sanitation technologies. Chapter eight summarises the key findings and proposes sanitation policies and strategies for supporting property owners and their tenants to gain access to sustainable sanitation. The chapter also proposes a research tool for examining demand for alternative sanitation technologies in low-income urban areas.

Bibliography

Abraham, B., Kakumbi, G. M., Alam, M. M., & Von Muench, E. (2011). *Alternative solutions for challenging environments: A look at UNICEF-assisted ecosan projects worldwide.* http://www.wedc.lboro.ac.uk/resources/conference/35/Abraham-B-1220.pdf.

Bhagwan, J. N., Still, D., Buckley, C., Foxon, K. (2008) Challenges with up-scaling dry sanitation technologies.*: Vol. 58. Water Science and Technology* (pp. 21-27).

Bracken, P., Münch, E. V., & Panesar, A. R. (2009). *Tackling the urban waste and food crises simultaneously and sustainably - Examples from the Philippines and Burkina Faso*.

Dangour, A. D., Watson, L., Cumming, O., Boisson, S., Che, Y., Velleman, Y., et al. (2013). Interventions to improve water quality and supply, sanitation and hygiene practices, and their effects on the nutritional status of children. *The Cochrane database of systematic reviews, 8*.

Endale, Y. T., Yirsaw, B. D., & Asfaw, S. L. (2012). Pathogen reduction efficiency of on-site treatment processes in eco-sanitation system. *Waste Management and Research, 30*(7), 750-754.

Eriksen, S., Aldunce, P., Bahinipati, C. S., Martins, R. D., Molefe, J. I., Nhemachena, C., et al. (2011). When not every response to climate change is a good one: Identifying principles for sustainable adaptation. *Climate and Development, 3*(1), 7-20. doi: 10.3763/cdev.2010.0060

Graham, J. P., & Polizzotto, M. L. (2013). Pit Latrines and Their Impacts on Groundwater Quality: A Systematic Review. *Environmental Health Perspectives, 121*(5), 521-530. doi: 10.1289/ehp.1206028

Hadi, A. (2000). A participatory approach to sanitation: Experience of Bangladeshi NGOs. *Health Policy and Planning, 15*(3), 332-337.

Haq, G., & Cambridge, H. (2012). Exploiting the co-benefits of ecological sanitation. *Current Opinion in Environmental Sustainability, 4*(4), 431-435. doi: 10.1016/j.cosust.2012.09.002

Hawkins, P., Blackett, I., & Heymans, C. (2014). The Missing Link in Sanitation Service Delivery: A Review of Fecal Sludge Management in 12 Cities. Washington, DC: WSP-World Bank Research Brief. http://www.wsp.org/.../WSP-Fecal-Sludge-12-City-Review-Research-Brief.pdf.

Isunju, J. B., Schwartz, K., Schouten, M. A., Johnson, W. P., & van Dijk, M. P. (2011). Socio-economic aspects of improved sanitation in slums: A review. *Public Health, 125*(6), 368-376.

IWA. (2014). Faecal Sludge Management, systems approach for implementation and operation. http://www.unesco-ihe.org/faecal-sludge-management-0.

Jackson, B. (2005). A Review of EcoSan Experience in Eastern and Southern Africa. http://www.susana.org/_resources/documents/default/2-295-jackson-2005-ecosan-experience-in-eastern-southern-africa-wspes.pdf.

Jenkins, M. W., Cumming, O., Scott, B., & Cairncross, S. (2014). Beyond 'improved' towards 'safe and sustainable' urban sanitation: assessing the design, management and functionality of sanitation in poor communities of Dar es Salaam, Tanzania. *Journal of Water, Sanitation and Hygiene for Development*

Jensen, P. K. M., Phuc, P. D., & West, L. G. K. (2010). How do we sell the hygiene message? with dollars, dong or excreta? *Environmental Health: A Global Access Science Source, 9*(1).

Langergraber, G., Muellegger, E. (2005). Ecological Sanitation - A way to solve global sanitation problems? *Environment International, 31*(3), 433-444.

Lüthi, C., Panesar, A., Schütze, T., Norström, A., McConville, J., Parkinson, J., et al. (2011). Sustainable sanitation in cities: a framework for action. Sustainable Sanitation Alliance (SuSanA), International Forum on Urbanism (IFoU), Papiroz Publishing House

Mariwah, S., & Drangert, J. (2011). Community perceptions of human excreta as fertilizer in peri-urban agriculture in Ghana. *Waste Management & Research, 29*(8), 815-822. doi: 10.1177/0734242x10390073

McGuire, S. J., & Sperling, L. (2008). Leveraging farmers' strategies for coping with stress: Seed aid in Ethiopia. *Global Environmental Change, 18*(4), 679-688. doi: http://dx.doi.org/10.1016/j.gloenvcha.2008.07.002

Mehl, J., Kaiser, J., Hurtado, D., Gibson, D. A., Izurieta, R., & Mihelcic, J. R. (2011). Pathogen destruction and solids decomposition in composting latrines: Study of fundamental mechanisms and user operation in rural Panama. *Journal of Water and Health, 9*(1), 187-199.

Meinzinger, F., Oldenburg, M., Otterpohl, R. (2009). No waste, but a resource: Alternative approaches to urban sanitation in Ethiopia. *Desalination, 248*(1-3), 322-329. doi: 10.1016/j.desal.2008.05.071

Milburn, A., Matsui, S., & Malmqvist, P. A. (2002) Workshop 8 (synthesis): Challenges of expanding ecological sanitation into urban areas. *Vol. 45* (pp. 195-198).

MIWD. (2008). The National Sanitation Policy, Malawi Government. http://www.ircwash.org/sites/default/files/842-MW06-19182.pdf.

Moe, C. L., Rheingans, R.D. (2006). Global challenges in water, sanitation and health. *Water and Health*.

Morgan, P., & Mekonnen, T. (2013). Paving The Way to Scaling Up: Factors contributing to the adoption of ecos-san toilets. http://shareresearch.org/.../morgan_and_mekonnen_2013_paving_the_way_to_scaling_up_ecosan.pdf.

Mugure, A., Mutua, B. . (2009). *Norms, attitudes and gender perspectives in ecological sanitation*.

Murungi, C., & van Dijk, M. P. (2014). Emptying, Transportation and Disposal of feacal sludge in informal settlements of Kampala Uganda: The economics of sanitation. *Habitat International, 42*, 69-75.

Nelson, D. R., Adger, W., & Brown, K. (2007). Adaptation to Environmental Change: Contributions of Resilience Framework. *Annual Review of Environment and Resources, 32*, 395-419.

NSO. (2008). Population and Housing Census, Preliminary Report. http://nsomalawi.mw/2008-population-and-housing-census/10-2008-phc-preliminary-results.html

NSO. (2011). Social Welfare Monitoring Survey. http://www.nsomalawi.mw/component/content/article/5/194-welfare-monitoring-survey-2011.html.

Okem, A. E., Xulu, S., Tilley, E., Buckley, C., Roma, E. (2013). Assessing perceptions and willingness to use urine in agriculture: a case study from rural areas of eThekwini municipality, South Africa. *Journal of Water, Sanitation and Hygiene for Development, 3*(4).

Peal, A., Evans, B., Blackett, I., Hawkins, P., & Heym, C. (2014). Fecal sludge management (FSM): analytical tools for assessing FSM in cities. *Journal of Water, Sanitation and Hygiene for Development., 4*(3), 371-383.

Peal, A., Evans, B., Blackett, I., Hawkins, P., & Heymans, C. (2014). Faecal sludge management: a comparative analysis of 12 cities. *Journal of Water, Sanitation and Hygiene for Development., 4*(4).

Prüss-Ustün, A., Bartram, J., Clasen, T., Colford, J. M., Cumming, O., Curtis, V., et al. (2014). Burden of disease from inadequate water, sanitation and hygiene in low- and middle-income settings: a retrospective analysis of data from 145 countries. *Tropical Medicine & International Health, 19*(8), 894-905. doi: 10.1111/tmi.12329

Radford, J. T., & Fenner, R. A. (2013). Characterisation and fluidisation of synthetic pit latrine sludge. *Journal of Water Sanitation and Hygiene for Development, 3*(3), 375-382.

Roma, E., Philp, K., Buckley, C., Xulu, S., & Scott, D. (2013). User perceptions of urine diversion dehydration toilets: Experiences from a cross-sectional study in eThekwini Municipality. *Water Sa, 39*(2), 305-311. doi: 10.4314/wsa.v39i2.15

Rosenboom, J. W., Jacks, C., Phyrum, K., Roberts, M., Baker, T. (2011). Sanitation marketing in Cambodia. *Waterlines, 30*(1), 21-40.

Rosenquist, L. E. D. (2005). A psychosocial analysis of the human-sanitation nexus. *Journal of Environmental Psychology, 25*(3), 335-346. doi: 10.1016/j.jenvp.2005.07.003

Smithers, J., & Smit, B. (1997). Human adaptation to climatic variability and change. *Global Environmental Change, 7*(2), 129-146.

Szanto, G. L., Letema, S. C., Tukahirwa, J. T., Mgana, S., Oosterveer, P. J. M., & van Buuren, J. C. L. (2012). Analyzing sanitation characteristics in the urban slums of East Africa. *Water Policy, 14*(4), 613-624. doi: 10.2166/wp.2012.093

Thye, Y. P., Templeton, M.R., Ali, M. (2011). A Critical Review of Technologies for Pit Latrine Emptying in Developing Countries. *Critical Reviews in Environmental Science and Technology, 41*(20), 1793-1819. doi: 10.1080/10643389.2010.481593

Tornatzky, L. G., & Klein, K. J. (1982). Innovation Characteristics and Innovation Adoption–Implementation: A Meta-Analysis of Findings. *IEEE Transactions on Engineering Management, 29, 28-45., 29*(1), 28-45.

Uddin, S., Muhandiki, V. S., Fukuda, J., Nakamura, M., & Sakai, A. (2012). Assessment of social acceptance and scope of scaling up urine diversion dehydration toilets in Kenya. *Journal of Water Sanitation and Hygiene for Development, 2*(3), 182-189. doi: 10.2166/washdev.2012.078

UN-HABITAT. (2011a). Malawi: Lilongwe Urban Profile. http://unhabitat.org/publications/malawi-lilongwe-urban-profile/.

UN-HABITAT. (2011b). Malawi: Blantyre Urban Profile. http://unhabitat.org/publications/malawi-Blantyre-urban-profile/.

Werner, C., Panesar, A., Rüd, S. B., Olt, C. U. (2009). Ecological sanitation: Principles, technologies and project examples for sustainable wastewater and excreta management. *Desalination, 248*(1-3), 392-401.

WHO. (2012). Soil-transmitted helminths infections. *Fact Sheet Number 366.*

WHO/UNICEF. (2014). Progress on Drinking Water and Sanitation - 2014 update. http://www.wssinfo.org.

Winblad, U. (2000). Sanitation without pollution. *Schriftenreihe des Vereins fur Wasser-, Boden- und Lufthygiene, 105*, 269-274.

WSP. (2004). Making toilets more affordable for the poor through microfinance: Lessons learned from introducing microfinance loans for sanitation in rural Cambodia. http://wsp.org/sites/wsp.org/files/publications/WSP-Learning-Note-Toilets-Through-Microfinance-Cambodia.pdf. *WSP - Learning Note*.

CHAPTER 2

UNDERSTANDING SANITATION TECHNOLOGY ACCEPTANCE & BEHAVIOUR CHANGE

2. Introduction

People in low-income countries install sanitation facilities on their own without dependence on government subsidies hence marketing techniques are increasingly advocated to stimulate behaviour change and household investment in sanitation improvement (Cairncross, 2004). The market approach to behaviour change focuses on understanding consumer needs, motivation for change and barriers preventing households from changing their behaviour (Budds et al., 2001; Kotler et al., 2002).

To influence people to change their sanitation behaviours, it is important that policy makers, sanitation managers and change agents first understand what people do to address their sanitation needs and how much they are willing to pay for sanitation products and services that they want (Cairncross, 2004). Sanitation policy makers and managers must also be knowledgeable about the local context including existing household sanitation behaviours and factors affecting decisions to adopt new behaviours (Jenkins & Scott, 2007). A clear understanding of factors that motivate households to adopt new sanitation behaviours is critical if alternative sanitation options are to be adopted and continuously used (Obika, Cotton, & Mkanga, 2006). It has been argued that sanitation projects fail to improve access to sanitation significantly when consumer motivations and barriers preventing behaviour change are not taken into consideration when designing and developing sanitation interventions (Altaf & Hughes, 1994).

2.1 Sanitation technology acceptance and behaviour change

In low-income urban areas, property owners and their tenants are familiar with building, using and maintaining pit latrines; the most common form of sanitation. The promotion of alternative sanitation technologies requires that property owners and their tenants change their behaviour regarding the way they build, operate and maintain sanitation facilities. Sanitation research has shown that the adoption of alternative sanitation options is a behavioural process with significant implications for sanitation technology and program design (Jenkins & Scott, 2007).

To maximise the potential benefits of interventions that aim at changing people's behaviour, it is important that policy makers, sanitation managers and change agents consider theories of behaviour change when designing and developing behaviour

change interventions (Aboud & Singla, 2012; Davis et al., 2015). Behaviour change theories describe how, when and why change occurs and they enable investigators to understand why interventions succeed or fail (Michie & Johnston, 2012). Although behaviour change theories offer useful guidance on how to successfully influence behaviour change, it is common for change agents to implement behaviour interventions without any reference to behaviour change theories (Davies et al., 2010).

There are several theories one could use to understand behaviour change. A scoping review to identify theories that could be used to design or evaluate public health interventions identified eighty two potential theories (Davis et al., 2015). Selecting appropriate theories to use can be very challenging considering this large number of theories, many of which have the same or overlapping constructs (Michie et al., 2005). This thesis used the theory of diffusion of innovation (Rogers, 1995), technology acceptance model (Davis, 1989) and the theory of planned behaviour (Azjen, 1991) to understand sanitation technology acceptance and behaviour change. These were found to be appropriate with regard to the adoption of an alternative sanitation technology.

2.1.1 The theory of diffusion of innovation

The theory of diffusion of innovation identifies five perceived attributes that affect the adoption and acceptance of an innovation or a new product. These attributes include: relative advantage, compatibility, complexity, trialability and observability (Rogers, 1995). The first three attributes have been found to be the most powerful determinants of innovation adoption (Tornatzky & Klein, 1982). These three attributes were defined by Rogers (1995) as follows: *relative advantage* is the degree to which an innovation is perceived as being better than the idea or technology it supersedes; *compatibility* is the degree to which an innovation is perceived as being consistent with existing values, past experiences and needs of potential adopters; *complexity* is the degree to which an innovation is perceived as relatively difficult to understand and use. According to Rogers (1995), people's perception about an innovation demonstrates the difficulties of adopting the innovation and offers useful information for product design.

2.1.2 Technology acceptance model

The technology acceptance model (TAM) has been widely used to predict and explain the acceptance of information technologies but it can also be used to investigate and understand the adoption of other new technologies (Davis, 1989). The model suggests that intention to use a new technology is determined by one's attitude towards using the technology and that attitude towards using a particular technology is determined by two specific beliefs: perceived usefulness and perceived ease of use. Perceived usefulness refers to a user's perception of the degree to which using a particular system will improve their performance and perceived ease of use refers to a user's perception of the extent to which using a particular system will be free of effort (Davis, 1989).

2.1.3 The theory of planned behaviour

The theory of planned behaviour has been widely used to understand a range of behaviours (Conner & Armitage, 1998). A central factor in the theory of planned behaviour is the individual's intention to perform a given behaviour. Intentions represent a person's motivation in the sense of her or his conscious plan or decision to exert effort to enact a given behaviour (Azjen, 1991). The theory of planned behaviour is built on three conceptually independent determinants of intention to engage in a particular behaviour (Azjen, 1991): attitude, subjective norm and perceived behavioural control. Attitude refers to the degree to which a person has favourable or unfavourable evaluation of a particular behaviour. Subjective norm refers to the influence of other people that are important to the decision maker and behavioural control refers to an individual's perceptions of how easy or difficulty it is to perform a particular behaviour and the absence of barriers or constraints likely to prevent an individual from performing a desired action for example lack of space, lack financial resources.

Research about adoption of alternative sanitation options confirms that people's attitude towards alternative sanitation options play a significant role in the selection of sanitation options. Research by Santos (2011) suggests that people's attitudes towards alternative sanitation options are key drivers underlying behaviour and affect individuals' choices and their decision making process towards different sanitation options. Reporting on the role of attitude on the choices that people make, McFadden (2015) indicated that attitudes reflect individuals' needs, values, tastes and capabilities

and are affected by socioeconomic and demographic characteristics of the individuals. Research carried out in Benin to examine the adoption of new sanitation behaviour suggests that households adopt new sanitation behaviour when there is sufficient awareness about the behaviour, strong desire for change and absence of barriers or constraints preventing households from changing their behaviour, e.g. materials, lack of space for sanitation, lack of skilled labour or knowledge (Jenkins & Curtis,2005). According Bagozzi (1999), desire for change arises out of dissatisfaction from perceived difference between a desired state and one's actual situation. In the case of ecological sanitation, desire for change may be associated with the need to own a permanent sanitation facility. To successfully promote alternative sanitation technologies and support urban residents to gain access to sustainable sanitation, it is therefore important that policy makers and change agents understand the attitude of property owners towards alternative sanitation technologies.

The theory of planned behaviour has a number of criticisms. One of the key criticisms is that intentions are often poor predictors of actual behaviour (Ajzen, 2011). There are cases where individuals indicate intention to act but subsequently fail to act (Orbell & Sheeran, 1998; Sniehotta et al., 2014). One of the reasons why intentions may not accurately predict behaviour is the duration between observation of intentions and implementation of actual behaviour. Research has shown that intentions and actual behaviour are strongly related when the time interval between assessment of intentions and observation of the behaviour is short because intentions or behavioural control factors are likely to remain stable over short periods of time (McEachan et al., 2011). However, even when intentions and actual behaviour are examined within short periods of time, intentions have been found to be poor predictors of actual behaviour (Kor & Mullan, 2011). Azjen (2011) explains that whether intentions predict behaviour depends in part on factors beyond the individual's control. The failure of the theory to accurately predict actual behaviour was not considered as a major constraint in this thesis as the key aim of the research was to use attitudes and subjective norms to predict intentions of property owners to adopt ecological sanitation in order to explain why its adoption has been very slow and to identify interventions that may increase its adoption.

The second criticism of the theory of planned behaviour is that it posits an impassionate, rational actor who reviews all available information in unbiased fashion to arrive at a decision; the theory does not sufficiently account for cognitive and affective processes

that are known to bias human behaviour (Ajzen, 2011; Sheeran et al., 2013). According to Ajzen (2011), this is a misinterpretation of the theory because people's attitude towards a particular behaviour, their subjective norms and their perceptions of behaviour control follow automatically from their beliefs but these beliefs are not formed in a rational unbiased fashion. Ajzen (2011) argues that beliefs reflect information that people have in relation to the performance of a given behaviour but this information is often inaccurate and incomplete; it may rest on faulty and irrational premises, be biased by self serving motives, fear and other emotions.

Other researchers have argue that the theory does not take into account other factors that may affect intentions and actual behaviour such as past behaviours, environmental conditions, personality traits and anticipated affective reactions (Conner & Armitage, 1998; Sniehotta, et al., 2014). According Conner and Armitage (1998), researchers can include factors that are deemed to be important in predicting intentions and behaviour.

2.2 Examining sanitation technology choices

The behavioural change theories discussed in the previous section offer useful frameworks for understanding factors affecting the adoption of ecological sanitation. However, ecological sanitation is just one product out of a range of sanitation products offered to residents in urban areas. When faced with a range of products or service options, consumers are known to choose options based on utility maximisation, i.e., individuals will choose an option that gives them maximum satisfaction (Gujarati, 2011) To understand consumer technology choices, one needs data about the choices people make and their socio-economic and demographic characteristics. Data about people's choices may be obtained from actual sales records (actual choice) but where sales records are not available, choices may be elicited through a stated preference survey (Ben-Akiva, 1994). With regard to sanitation marketing, local organisations and individuals providing sanitation products and services in low-income urban areas rarely keep comprehensive records about people's choices and their socioeconomic and demographic characteristics. In addition, one cannot be sure of the choice options that were available to urban residents when they were making their choices.

2.3 Data collection and analysis

Data were collected from the two cities using mixed methods research. Mixed methods research involves the collection of both qualitative and quantitative data. The method recognises the importance of traditional quantitative and qualitative research and offers a powerful third paradigm that often will provide the most informative, complete and balanced research results (Creswell, 2003; Johnson et al., 2007). The key advantage of mixed methods research is that the weaknesses of one method are strengthened by the other method (Johnson & Onwuegbuzie, 2004). [a] The qualitative investigation was exploratory in nature and they was carried out to elicit meaning, gain understanding and develop empirical knowledge about ecological sanitation and local adaptation strategies property owners implement where there is concern about space for replacing pit latrines, [b] The quantitative investigation was used to test hypotheses generated from the qualitative investigation and to examine the extent of the problem of availability of space for replacing pit latrines in low-income and high population density urban areas.

2.3.1 Qualitative investigation

Data collection started with a series of in-depth interviews (IDIs) and focus group discussions (FGDs) which targeted property owners with and without ecological sanitation as well as tenants using and not using ecological sanitation. Purposeful sampling was used to recruit research participants and a series of interviews were carried out until additional interviews were not revealing new themes. To safeguard validity in the qualitative data, information gathered from property owners was triangulated or compared with data gathered from tenants, builders and hygiene promoters (Mays, 1995). The IDIs and FGDs were recorded using digital recorders and transcribed using Microsoft Word. Qualitative data were analysed using thematic analysis (Ritchie, 2003). The process of analysing the data involved the following: listening to digital recordings and reading transcripts, identifying key themes and generating a thematic framework using Microsoft Excel Spreadsheets, rearranging the data according to the appropriate part of the thematic framework to which they related, interpretation of the results and finding association between the themes. Results from the IDIs and FGDs were used to develop a list of statements which captured positive and negative perceptions towards ecological sanitation. This list was used in a survey to examine the attitude of property owners towards ecological sanitation.

2.3.2 Stated preference survey

The IDIs and FGDs were followed by a stated preference survey. The survey targeted property owners only (landlords) because it is mainly property owners that are responsible for installing new sanitation facilities or making decisions about alternative sanitation technologies. The survey targeted 1,300 property owners from 27 low-income and high population density urban areas (appendix 13). The targeted areas were selected based on probability proportion to population. These areas were identified from a list of low income, high population density urban areas prepared by the Lilongwe and Blantyre City Councils under the Participatory Slum Upgrading Programme (UN-HABITAT, 2011a, 2011b). The sample size was calculated to estimate the proportion of property owners concerned about space for replacing pit latrines. The sample size was estimated as follows (Wilson, 2012):

$$N = \frac{Z^2\,[P(1-P)]}{E^2}$$

Where: Z is the level of confidence expressed in standard errors, E is the acceptable amount of sampling error and P is the proportion of the population having a certain characteristic (estimated at 26% from formative research). The sample size was calculated for each city and in each city; the sample was doubled to take account of clustering (Kirkwood & Sterne, 2003). A two stage sampling technique was used to select property owners. In the first stage, low-income urban areas were selected based on probability proportion to population. In the second stage, research assistants sampled property owners randomly by starting from a central point and selecting every 5^{th} house until they interviewed a specified number of property owners (Bostoen, 2006).

The survey accomplished four objectives: (1) The survey examined sanitation technology choices of property owners. To examine sanitation technology choices, a range of sanitation options were offered to survey respondents. These options included: urine diverting, fossa alterna, pour flush, pit latrines with slab/cement floor, lined pit latrines and a pit emptying service (appendix 1). The pit emptying service was based on a gulper – a manually operated pit emptying equipment. Alternative options (Urine diverting, Fossa alterna, Pour flush and a Gulper were introduced to survey respondents using photographs (appendix 2). Survey respondents were informed that they could select any of the options offered or any other technology of their choice including pit latrines with mud floor (unimproved sanitation) and septic tank toilets. (2) The survey

also examined the effect of microfinance for sanitation on sanitation technology choices. Survey respondents were offered an option for microfinance at 2% monthly interest and were asked to select any amount depending on the sanitation technology they wanted. Respondents were given an option of paying back their loan within 12 months or 24 months. Microfinance information provided to survey respondents is shown on appendix 2b. The microfinance offer was based on a sanitation loan program which was being implemented in the survey areas by an organisation called Centre for Community Organisation and Development (CCODE). CCODE offers microfinance for sanitation at 2% monthly interest rate. (3) The survey examined the attitude of property owners towards ecological sanitation and their intention to adopt ecological sanitation. Results from the IDIs were used to develop a list of statements that captured positive and negative perceptions towards ecological sanitation. Survey respondents were asked to indicate whether they strongly agreed, agreed, disagreed or strongly disagreed with the statements. (4) The survey also examined the effect of increasing pit emptying service fees on demand for ecological sanitation and pit emptying services. Property owners in one of the two cities (Blantyre) were offered a lower (MK10, 000) and higher pit emptying service fee (MK20, 000).

2.3.2.1 Analysis of stated preference survey data

Data were processed using EpiData version 3.1 and analysed using Stata version 12.
Three approaches were used to analyse survey data and understand the choices property owners make or are likely to make when offered a range of sanitation options: binary logistic regression models, multinomial logistic regression and ordered logistic regression. To identify drivers of demand for ecological sanitation and barriers affecting its adoption, binary logistic regression models were used. Binary logistic regression models are used when a dependent variable has two outcomes and a researcher wants to explore how each explanatory variable affects the probability of an event occurring (Long & Freese, 2006). In the analysis, the dependent variable was intention to adopt ecological sanitation (Urine diverting toilet) and the attitude/perception of property owners were used as explanatory variables. Because the IDIs yielded a large set of positive and negative attributes/perceptions, I used factor analysis to explore the relationship among these attributes/perceptions and to reduce them to a more manageable size. I used the *eigenvalue one* test to select the number of factors to include in the binary logistic regression model (Norman, 2000). To develop binary

logistic regression model, Urine diverting toilet was coded as *1* if a property owner selected a Urine diverting toilet from the list of options that were offered and *0* if a property owner selected other options e.g. Pour flush or pit latrines.

Multinomial logistic regression models were used to understand the choices of property owners and the characteristics of property owners that are likely to accept or reject ecological sanitation (Urine diverting toilets & Fossa alterna). Multinomial logistic regression models are used when the dependent variable has more than two categories which cannot be ordered and a researcher desires to explore the probability of an event occurring relative to a reference category (Gujarati, 2011; Long & Freese, 2006). Where the aim was to understand the characteristics of property owners that are likely to accept or reject ecological sanitation, ecological sanitation was used as the reference category. Where the aim was to examine technology choices where there is concern about space for replacing pit latrines; unlined pit latrines were used as the reference category.

Ordered logistic regression was used to examine the characteristics of property owners that were concerned about space for replacing pit latrines. Ordered logistic regression is used when response categories are ordered or ranked and the distance between the categories is unknown for example survey questions, that asks respondents to indicate whether they strongly agree, agree, disagree and strongly disagree to a particular statement (Long & Freese, 2006).

To examine attitudes that are positively or negatively associated with intention to adopt ecological sanitation, data were analysed in four different ways: (1) the first set of regression models focused on respondents that were planning to construct new sanitation facilities within twelve months after they were interviewed, (2) the second set of regression models focused on respondents that were planning to construct new sanitation facilities within two years after they were interviewed, (3) the third set of regression models focused on all the respondents regardless of the time they were planning to construct new sanitation facilities and (4) the last set of regression models focused only on respondents that had prior knowledge of ecological sanitation. The last set of models reflect the observation that decisions to adopt an innovation begins when an individual is exposed to an innovation and understands how it works (Rogers, 1995).

Table 2.1: Summary of data collection and analysis methods

Research Method	**Brief description about data collection method, participants and data analysis.**
In-depth interviews and focus group discussions	In-depth interviews and focus group discussions were carried to explore: (i) The attitude of property owners towards ecological sanitation, (ii) conditions causing property owners to become concerned about space for replacing pit latrines, (iii) strategies property owners adopt where there is concern about space for replacing pit latrines. Interviews targeted property owners, tenants, hygiene promoters and builders. Data were recorded using digital recorders and analysed using thematic analysis.
Stated preference survey	*Survey purpose 1:* To examine sanitation technology choices and identify socioeconomic indicators of demand for ecological sanitation. All Property owners in two cities were offered a range of sanitation technologies and a pit emptying service. Alternative technologies were introduced to property owners using photographs. Technology choices were examined using multinomial logistic regression.
	Survey purpose 2: To examine the effect of improving access to microfinance for sanitation on sanitation technology choices and demand for ecological sanitation. All property owners were offered microfinance for sanitation option. Property owners that accepted the microfinance offer were asked to indicate the technology they would choose if microfinance for sanitation was made available.
Stated preference survey	*Survey purpose 3:* (3.1) Examine the effect of increasing pit emptying service fees on demand for pit emptying service and ecological sanitation. Property owners from Blantyre City only were offered pit emptying service at a lower and a higher service fee. Choices made under these two conditions were used to calculate price elasticity of demand for pit emptying service and examine the effect of an increase pit emptying service fees on the adoption of ecological sanitation.
	Survey purpose 4: (4.1) To examine the proportion of property owners concerned about space for pit latrines. (4.2) To examine property conditions (e.g. number of people) associated with concern about space for pit latrines. (4.3) Examine whether concern about space is associated with demand for ecological sanitation. Property owners were asked to indicate their level of concern about space for pit latrines using a 4- point likert scale. Data was analysed using multivariable binary logistic regression.
	Survey purpose 5: (5.1) Examine the attitude of property owners towards ecological sanitation. (5.2) Examine attitudes that are positively or negatively associated with demand for ecological sanitation. In Lilongwe City, property owners evaluated a larger set of positive and negative attributes of ecological sanitation than in Blantyre City. Data analysis focussed on urine diverting toilets. Data was analysed using binary logistic regression and multivariable binary logistic regression.

Bibliography

Aboud, F., & Singla, D. (2012). Challenges to changing health behaviours in developing countries: A critical overview. *Social Science & Medicine, 75*(2012), 598-594.

Ajzen, I. (2011). The theory of planned behaviour: Reactions and reflections. *Psychology and Health, 26*(9), 1113-1127.

Altaf, M. A., & Hughes, J. A. (1994). Measuring the Demand for Improved Urban Sanitation Services - Results of a Contingent Valuation Study in Ouagadougou, Burkina-Faso. *Urban Studies, 31*(10), 1763-1776. doi: 10.1080/00420989420081621

Azjen, I. (1991). The Theory of Planned Behaviour *ORGANISATIONAL BEHAVIOR AND HUMAN DECISION PROCESSES, 50*(1991), 179-211.

Bagozzi, R. P., Dholakia, U. (1999). Goal Setting and Goal Striving in Consumer Behaviour. *Marketing 1999*(63), 19.

Ben-Akiva, M. (1994). Combining Revealed and Stated Preferences Data. *Marketing Letters 5*(4), 335-350.

Bostoen, K., Chalabi, Z. (2006). Optimization of household survey sampling without sample frames. *International Journal of Epidemiology, 35*(3), 751-755.

Budds, J., Curtis, V., Howard, G., & Saywell, D. (2001). *Social marketing for urban sanitation*.

Cairncross, S. (2004). The case for marketing sanitation. http://wsp.org/UserFiles/file/af_marketing.pdf.

Conner, M., & Armitage, C. J. (1998). Extending the Theory of Planned Behavior: A Review and Avenues for Further Research. *Applied Social Psychology, 28*(15), 1429 - 1464.

Creswell, J. (2003). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches.* SECOND EDITION. SAGE Publications.

Davies, P., Walker, A. E., & Grimshaw, J. M. (2010). A systematic review of the use of theory in the design of guideline dissemination and implementation strategies and interpretation of the results of rigorous evaluations. *Implementation Science, 5*(14).

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use and User Acceptance of Information technology. *Management Information Systems Quarterly 13*(3), 319-340.

Davis, R., Campbell, R., Hildon, Z., Hobbs, L., & Michie, S. (2015). Theories of behaviour and behaviour change across the social and behavioural sciences: a scoping review. *Health Psychology Review, 9*(3), 323-344.

Gujarati, D. (2011). *Econometrics by Example*. Palgrave Macmillan, New York.

Jenkins, M., & Scott, B. (2007). Behavioral indicators of household decision-making and demand for sanitation and potential gains from social marketing in Ghana. *Social Science & Medicine, 64*(12), 2427-2442.

Jenkins, M. W., & Curtis, V. (2005). Achieving the "good life": Why some people want latrines in rural Benin. *Social Science & Medicine, 61*(2005), 2446-2459.

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a Definition of Mixed Methods Research. *Journal of Mixed Methods Research, 1*(112).

Johnson, R. B., Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational researcher, 33*(7), 14-26.

Kirkwood, B. R., & Sterne, J. A. C. (2003). Medical Statistics, 3rd edition. Blackwell Publishing, Oxford.

Kor, K., & Mullan, B. A. (2011). Sleep hygiene behaviours: An application of the theory of planned behaviour and the investigatior of perceived autonomy support, past behavior and response inhibition. *Psychology and Health, 26*, 1208 - 1224.

Kotler, P., Roberto, N., & Lee, N. (2002). Social Marketing: Improving the Quality of Life. Sage Publication California.

Long, J. S., & Freese, J. (2006). *Regression Models for Categorical Dependent Variables Using Stata*. Second Edition. Stata Press Publication, Texas.

Mays, N., Pope, C. (1995). Rigour and qualitative research. *British Medical Journal, 311*(1995), 109-112.

McEachan, R. R. C., Conner, M., Taylor, N. J., & Lawton, R. J. (2011). Prospective prediction of health-related behaviours with the Theory of Planned Behaviour: a meta-analysis. *Health Psychology Review, 5*(2), 97-144. doi: 10.1080/17437199.2010.521684

Michie, S., & Johnston, M. (2012). Theories and techniques of behaviour change: Developing a cumulative science of behaviour change. *Health Psychology Review, 6*(1).

Michie, S., Johnston, M., Abraham, C., Lawton, R., Parker, D., Walker, A., et al. (2005). Making psychological theory useful for implementing evidence based practice: A consensus approach. *Quality & Safety in Health Care, 14*(1), 26-33.

Norman, G. R., Streiner, D.L. (2000). *Biostatistics: The Bare Essentials.* 2nd Edition. BC Decker, Ontario.

Obika, A. E. U., Cotton, A. P., & Mkanga, M. (2006). Creating demand for urban sanitation in sub-Saharan Africa. *Proceedings of the Institution of Civil Engineers-Municipal Engineer, 159*(1), 29-35.

Orbell, S., & Sheeran, P. (1998). Inclined abstainers: A problem for predicting health-related behaviour. *British Journal of Social Psychology, 37*, 151-165.

Ritchie, J. E., Lewis, J. eds. (2003). *Qualitative Research Practice: A Guide for Social Science Students and Researchers*. London: Sage.

Rogers, E. M. (1995). *Diffusion of Innovations*. Free Press, New York.

Santos, A. C., Roberts, Jennifer A., Barreto, Mauricio L., Cairncross, Sandy. (2011). Demand for sanitation in Salvador, Brazil: A hybrid choice approach. *Social Science & Medicine, 72*(8), 1325-1332. doi: 10.1016/j.socscimed.2011.02.018

Sheeran, P., Gollwitzer, P. M., & Bargh, J. A. (2013). Nonconscious processes and health. *Health Psychology, 32*, 460 - 473.

Sniehotta, F. F., Presseau, J., & Araújo-Soares, V. (2014). Time to retire the theory of planned behaviour. *Health Psychology Review, 8*(1), 1-7.

Tornatzky, L. G., & Klein, K. J. (1982). Innovation Characteristics and Innovation Adoption–Implementation: A Meta-Analysis of Findings. *IEEE Transactions on Engineering Management, 29, 28-45.*, *29*(1), 28-45.

UN-HABITAT. (2011a). Malawi: Lilongwe Urban Profile. http://unhabitat.org/publications/malawi-lilongwe-urban-profile/.

UN-HABITAT. (2011b). Malawi: Blantyre Urban Profile. http://unhabitat.org/publications/malawi-Blantyre-urban-profile/.

Wilson, A. M. (2012). *Marketing Research: An Integrated Approach.* 3rd edition. Prentice Hall, California.

WSSCC. (2015). Urban Sanitation. http://www.wsscc.org/topics/sanitation/urban-sanitation.

CHAPTER 3

SANITATION TECHNOLOGY CHOICES
WITH & WITHOUT MICROFINANCE FOR SANITATION

Figure 3. 1: Interior view of urine diverting toilet

Figure 3. 2: Interior view of fossa alterna toilet

Figure 3. 3: Pit latrine slab

Figure 3. 4: Pour flush toilet - Interior

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Figure 3. 5: Pit latrine - mud floor

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SANITATION TECHNOLOGY CHOICES WITH & WITHOUT MICROFINANCE FOR SANITATION

ABSTRACT

This chapter examines sanitation technology choices of property owners and the effect of microfinance for sanitation on sanitation technology choices. A range of sanitation options plus microfinance for sanitation were offered to 1,300 property owners sampled from 27 low-income and high population density urban settlements. Choices of property owners were examined before and after the property owners were offered an option for microfinance for sanitation. Before the microfinance option was offered, 13% selected ecological sanitation but when microfinance was offered, 32% selected ecological sanitation. The results show that property owners in the lowest income category compared to those in the highest income category were 8.4 times more likely to select unimproved sanitation over ecological sanitation ($p < 0.001$), property owners in the lowest income category compared to those in the highest income category were less likely to select pour flush/septic tank toilets over ecological sanitation (RRR = 0.2, $p < 0.001$). The results also show that property owners that were using lined pit latrines compared to those that were not using lined pit latrines were 11.8 times more likely to select pit emptying service over ecological sanitation ($p < 0.001$). The results suggest that socioeconomic and demographic characteristics of property owners and access to microfinance for sanitation play a significant role in sanitation technology choices that property owners make. The design and promotion of alternative sanitation technologies should therefore be sensitive to the socioeconomic and demographic characteristics of the target audience. However, without improving access to microfinance for sanitation, the promotion of alternative sanitation technologies will not significantly increase the proportion of urban residents gaining access to sustainable sanitation.

3. Introduction

In rapidly urbanising cities in low-income countries, a key challenge facing many city authorities is how to collect, treat and safely dispose faecal sludge from pit latrines (Hawkins, et al., 2014). Usually, pit latrines are emptied manually and the contents are often discharged into water ways and storm water drains untreated, exposing many people to infection and disease (Peal et al., 2014). The promotion of alternative sanitation technologies and improvements in hygienic pit emptying services, are seen as key strategies that would support urban residents in low-income areas to gain access to sustainable sanitation (Abraham, et al., 2011; Thye et al., 2011; Uddin, et al., 2012).

The promotion of alternative sanitation technologies and hygienic pit emptying services is likely to increase the range of sanitation options available to urban residents. The choices that property owners make when faced with a range of sanitation options have important implications on urban sanitation policies, strategies and investment plans for improving access to sustainable sanitation. However, very little is known about the choices that property owners make or are likely to make when offered a range of sanitation options. Yet, successful sanitation marketing must be based on a clear understanding of what consumers want and on which sanitation technologies are locally appropriate (Jenkins, 2004). Commenting on the importance of understanding what consumer want, Altaf and Hughes (1994) noted that misjudgements about what consumers want often lead to poor project design and performance.

This chapter sets out to examine socioeconomic and demographic indicators of demand for ecological sanitation and the effect of microfinance for sanitation on sanitation technology choices. Data were collected through a stated preference survey. Property owners were offered a range of sanitation technology options plus a pit emptying service option. Sanitation technology choices were examined before and after property owners were offered an option for microfinance for sanitation. The stated preference survey targeted property owners only as they are the ones usually responsible for installing new sanitation facilities and making decisions about alternative sanitation technologies. The chapter proposes strategies for improving access to sustainable sanitation in low-income and high population density urban areas.

3.1 Materials and methods

Data collection

Data were collected from Lilongwe and Blantyre City. Due to unavailability of reliable sales data from entrepreneurs and local organisations promoting sanitation in low-income and high population density urban areas, stated preference survey was used to examine sanitation technology choices among property owners. A range of sanitation technology options plus a pit emptying service were offered to 1,300 property owners as described in chapter 2. Property owners were offered an opportunity for microfinance for sanitation. Microfinance was offered at 2% monthly interest rate to be paid back over a period of 2 years (appendix 3). Amounts offered covered the cost of purchasing construction materials and labour.

Data Analysis

Multinomial logistic regression models were developed to examine the likelihood of selecting a particular sanitation technology relative to a reference category, as measured by the Relative Risk Ratio (RRR). Ecological sanitation (Urine diverting toilet and Fossa alterna) served as the reference category. A series of univariable analyses were conducted to select variables to include in the multinomial regression models. Variables that had a p-value of 0.20 or less were selected for inclusion in the final model as independent variables (Hosmer, 2013). The data were analysed using Stata version 12, and all analyses used 5% significance level. Data analysis excludes observations from 51 property owners due to inconsistency of their data (they selected ecological sanitation but indicated that they could not afford it). Regression models also excluded 32 property owners that were using ecological sanitation.

3.2 Results

Descriptive statistics of the sampled properties are shown on table 3.1. Fifty one percent were using unlined pit latrines[8], 28% of the properties had unimproved

[8] Pit latrines with slab/cement floor whose vaults are not lined with bricks and cement

sanitation, 17% had lined pit latrines[9] and there were no sanitation facilities at 19 properties (1%). Twenty eight properties (2%) had Urine diverting toilets and only 4 properties had Fossa alterna toilets. Pour flush toilets were rare as only 1 property had a pour flush toilet. Many property owners (65%) were living with tenants while 35% did not have tenants at their properties.

Table 3.1: Descriptive statistics of sampled properties (n=1,300)

Variable	***Freq***	***%***	***Mean***	***Std***	***Max***
Type of sanitation facility in use					
Unlined pit latrine	658	51			
Unimproved sanitation (mud floor)	363	28			
Lined pit latrine	227	17			
Pour flush toilet	1	0			
Urine diverting toilet	28	2			
Fossa alterna toilet	4	0			
No sanitation facility at the property	19	1			
Presence of tenants					
No	460	35			
Yes	840	65			
Knowledge of ecological sanitation					
No	409	31			
Yes	891	69			
Access to a garden					
No	852	66			
Yes	448	34			
Gender of property owner					
Female	329	25			
Male	971	75			
Education of property owner					
None	61	5			
Primary school	543	42			
Secondary school	588	45			
College education	108	8			
Number of houses/households at a property			3	2	15
Number of people at a property			11	7	56

Note: properties that had septic tank toilets were excluded from the survey as they already have a sustainable sanitation technology.

3.2.1 Indicators of demand for microfinance for sanitation

When microfinance was offered, 48% accepted the microfinance offer, 46% declined the offer and 6% were not sure whether they would take a loan or not. The decision

[9] Pit latrines with the vaults lined with bricks and cement to stop pits from collapsing.

to accept or reject microfinance was significantly associated with income status, knowledge of ecological sanitation, high level of concern about space for replacing pit and access to lined pit latrines (table 3.2). Property owners in the highest income category compared to property owners in the lowest income category were 2 times more likely to accept microfinance for sanitation. With regard to the type of pit latrine in use, the results show that property owners that were using lined pit latrines compared to those that were using unlined pit latrines were less likely to accept the microfinance offer (OR =0.5). The results also show that a unit increase in the level of concern about space for replacing pit latrines increased the odds of accepting microfinance for sanitation (OR=1.2). The results further show that property owners that had prior knowledge of ecological sanitation compared to those that did not have any prior knowledge were 1.3 times more likely to accept the microfinance offer.

Table 3.2: Socioeconomic indicators of demand for microfinance (n=1145)

Variable	n	OR	p-value	95% Conf.int
Income status of property owner				
MK<20,000 (ref)	380			
MK20,000- MK40,000	394	1.4	0.04	1.0 - 1.8
>MK40,000	371	2.0	0.00	1.5 - 2.8
Type of current sanitation				
Unlined pit latrines (ref)	587			
Unimproved sanitation	331	1.1	0.37	0.9 - 1.5
Lined pit latrines	209	0.5	0.00	0.3 - 0.6
No sanitation facility	19	1.0	0.97	0.4 - 2.6
Access to a garden for food production				
No (ref)	751			
Yes	394	1.2	0.10	1.0 - 1.6
Knowledge of ecological sanitation				
No (ref)	378			
Yes	767	1.3	0.02	1.0 - 1.7
Concern about space for sanitation		1.2	0.01	1.0 - 1.3
_cons		0.5	0.00	0.4 - 0.7

Notes: sample excludes those with ecological sanitation, pour flush toilets, those not sure about taking a loan (70) and those whose choices were rejected because of inconsistency of their data (51).
Probability chi2 = 0.000, LR chi2 (9) = 61.97, Pseudo R-squared = 0.04

3.2.2 Technology choices with and without microfinance

Offering property owners microfinance for sanitation significantly reduced the proportion of property owners that selected unimproved sanitation and pit emptying service while the proportion of ecological sanitation, pour flush toilets, lined pit latrines and unlined pit latrines increased significantly (table 3.3)

Table 3.3: Sanitation technology choices with and without microfinance (*n* =1217)

Technology choice	(1) Choices before microfinance was offered		(2) Choices after microfinance was offered		*(3) Chi-square*
	n	*%*	*n*	%	
Septic tank	16	1%	17	1%	0.32
Pour flush toilets	43	4%	102	8%	0.00
Lined pit latrine	172	14%	192	16%	0.02
Unlined pit latrine	427	35%	273	22%	0.00
Pit emptying service	232	19%	145	12%	0.00
Unimproved sanitation	172	14%	100	8%	0.00
Ecological sanitation					
Urine diverting	68	6%	183	15%	0.00
Fossa alterna	87	7%	205	17%	0.00
Total	1217	100%	1217	100%	

Notes: Sample excludes 32 property owners that were using ecological sanitation and 51 property owners whose choices were rejected because of inconsistency of their data.

Microfinance offer allowed property owners to switch from one technology to another (table 3.4). About 50% (46 out of 85) of those that selected pit emptying service before microfinance was offered switched to ecological sanitation after they accepted the microfinance offer and nearly 70% (50 out of 72) of those that selected unimproved sanitation before microfinance for sanitation was offered switched to ecological sanitation after they accepted the microfinance offer. The cheaper type of ecological sanitation (Fossa alterna) was more popular among property owners that selected unimproved sanitation before they accepted the microfinance offer. In total, 28% of property owners that accepted microfinane for sanitation selected Urine diverting toilets and 30% selected Fossa alterna toilets. Thus 58% of property owners that accepted the microfinance offer selected ecological sanitation.

Table 3.4: Technology replacement after accepting microfinance (*n* = 592)

Choices of property owners before they accepted microfinance			Technology replacement after accepting microfinance							
Technology	*n*	%	Septic tank	Pour flush toilet	Lined pit latrine	Unlined pit latrine	Pit emptying service	Unimproved sanitation	*Ecological sanitation*	
									UDT	Fossa alterna
Septic tank	4	*1%*	4	0	0	0	0	0	0	0
Pour flush	30	*5%*	0	30	0	0	0	0	0	0
Lined pit latrine	83	*14%*	0	9	54	0	0	0	13	7
Unlined pit latrine	208	*35%*	0	28	22	43	0	0	47	68
Pit emptying service	85	*14%*	1	18	17	3	0	0	33	13
Unimproved sanitation	72	*12%*	0	3	11	8	0	0	17	33
Ecological sanitation										
Urine diverting	51	*9%*	0	0	0	0	0	0	51	0
Fossa alterna	59	*10%*	0	0	1	1	0	0	3	54
Total	592	*100%*	5	88	105	55	0	0	164	175
%			*1%*	*15%*	*18%*	*9%*	*0%*	*0%*	*28%*	*30%*

Notes: The sample excludes property owners that declined the microfinance offer, those that had access to ecological sanitation and also property owners whose choices were rejected.

3.2.3 Indicators of demand for ecological sanitation

The results show that income status, type of pit latrine in use, number of households at a property, access to a garden for food crop production, availability of piped water at a property and knowledge about ecological sanitation play a significant role in the choices that property owners make (table 3.5). Property owners that were using lined pit latrines compared to those using unlined pits were 11.8 times more likely to select pit emptying service over ecological sanitation and property owners in the lowest income category compared to those in the highest income category were 8.4 times more likely to select unimproved sanitation over ecological sanitation. The results also show that property owners in the highest income category compared to those in the lowest income category were less likely to select ecological sanitation over pour flush/septic tank toilets (RRR = 0.4).

Table 3.5: Socioeconomic and demographic indicators of demand for ecological sanitation (n=1217)

Variable	n	Pour flush/septic tank		Lined pit latrine		Pit latrine, cement floor		Pit latrine, mud floor		Pit latrine emptying	
		RRR	95% CI	RRR	95% CI	RRR	95% CI	RRR	95% CI	RRR	95% CI
Income status											
MK>40,000 (ref)	402										
MK20,000 - MK40,000	419	0.4**	0.2-0.6	0.9	0.6-1.4	1.6*	1.0-2.4	3.6*	1.2-11.1	1.0	1.0-1.6
<MK20,000	396	0.2***	0.1-0.4	0.7	0.5-1.2	2.2***	1.4-3.3	8.4***	2.9-24.8	0.8	0.4-1.5
Type of pit latrine in use											
Unlined pit latrine (ref)	633										
Unimproved sanitation (mud floor)	345	0.6	0.3-1.0	1.3	0.9-2.1	0.4***	0.3-0.7	16.3***	7.1-37.5	0.0	
No sanitation facility	19	0.0	0.2-1.1	1.0	0.3-4.0	0.4	0.1-1.2	4.8	1.0-23.7	0.0	
Lined pit latrine	220	0.9	0.5-1.7	1.5	0.9-2.4	0.1***	0.0-0.2	1.2	0.2-6.2	11.8***	7.2-19.2
Number of households at a property		1.0	0.9-1.1	1.1*	1.0-1.2	1.0	0.9-1.1	0.9*	0.8-1.0	1.0	0.9-1.1
Access to a garden											
No (ref)	806										
Yes	411	0.7	0.4-1.0	1.0	0.7-1.4	0.6*	0.5-0.9	0.6*	0.4-1.0	0.6*	0.4-1.0
Has piped water on the yard											
No (ref)	793										
Yes	424	1.6*	1.0-2.5	1.3	0.9-1.9	1.1	0.8-1.6	0.8	0.4-1.6	1.1	0.7-1.7
Knowledge of UDT											
No (ref)	399										
Yes	818	0.4***	0.3-0.7	0.6*	0.4-0.8	0.6*	0.4-0.8	0.4***	0.2-0.7	0.6*	0.4-1.0
cons		1.3	0.7-2.5	0.5	0.3-0.8*	1.1*	0.7-1.9	0.1*	0.0-0.1	0.4	0.2-0.7

Notes: Results from multinomial logistic regression using ecological sanitation as the reference category (UDT and fossa alterna toilets). The model was based on choices made when microfinance was offered. The model includes both those that accepted and did not accept microfinance. Data excludes property owners with ecological sanitation and property owners whose choices were rejected because of inconsistency of their data (51).

Probability>chi2= 0.000, LR chi2 (45) = 724.78, Pseudo R-squared =0.17

With regard to the number of households at a property, the results on table 3.5 show that a unit increase in the number of households at a property increased the likelihood of selecting lined pit latrines over ecological sanitation (RRR = 1.1). With regard to access to gardens for food crop production, the results show that property owners that had gardens for food crop production compared to property owners that did not have gardens were less likely to select unimproved sanitation or pit latrines with cement floor over ecological sanitation (RRR = 0.6). The results further show that property owners that had prior knowledge of ecological sanitation were more likely to select ecological sanitation over all the other sanitation options offered. A second model (using choices respondents made before microfinance was offered) shows no difference in intention to adopt ecological sanitation between property owners that had prior knowledge of ecological sanitation and those that did not have knowledge (appendix 4). This suggests that without microfinance for sanitation, efforts to increase awareness about alternative sanitation technologies may not significantly increase the adoption of alternative sanitation technologies. The second model also showed no difference in intention to adopt ecological sanitation between property owners that had access to gardens for food crop production and property owners that did not have access to gardens.

3.3 Discussion

Through a stated preference survey, this chapter examined sanitation technology choices property owners make or are likely to make when offered a range of sanitation technology options, pit emptying service and microfinance for sanitation. The results suggest that socioeconomic and demographic characteristics of property owners and microfinance for sanitation play a significant role in sanitation technology choices that property owners in low-income and high population density urban areas make.

Income and installation cost of ecological sanitation

Research has shown that financial resources play a significant role in sanitation technology choices. A study about access safe and sustainable sanitation in Dar es Salaam, Tanzania showed that access to safe and sustainable sanitation was 2.6 times greater among the richer households than poorer households (Jenkins, et al., 2013). Other studies have also shown a strong association between income and access to improved sanitation (Moseti, et al., 2009; Tumwebaze & Luthi, 2013). The results

confirm these observations. Property owners in the lowest income category compared to those in the highest category were 8.4 times more likely to select unimproved sanitation over ecological sanitation ($p < 0.001$). The results also showed that property owners in the lowest income category compared to those in the highest category were less likely to select pour flush/septic tank toilets over ecological sanitation (RRR = 0.2, $p < 0.001$).

The installation cost of ecological sanitation is often identified as the reason for the slow adoption of ecological sanitation (Tadesse, 2011; Uddin et al., 2014). The results from this study suggest that the slow adoption of ecological sanitation is not only because the installation cost of the technology is too high but also because the technology does not meet the aspirations of wealthier property. The results suggest that wealthier property owners prefer pour flush/septic tank toilets over ecological sanitation. Ironically, local organisations in the study areas were not promoting pour flush toilets as much as they were promoting ecological sanitation - only one household had a pour flush toilet while 32 had ecological sanitation in the sample.

Access to gardens for food crop production and demand for ecological sanitation

Recycling human excreta to access cheap fertiliser for food crop production is one of the key advantages of ecological sanitation (Bracken, et al., 2009; Haq & Cambridge, 2012). The results show that ecological sanitation is important among urban households with access to gardens for food crop production. Property owners that had access to gardens for food crop production were less likely to select unimproved sanitation or pit latrines with slab/cement floor over ecological sanitation (RRR=0.6, $p <0.05$). However, fewer property owners are likely to benefit from access to recycled human excreta because of lack of access to gardens (66% of property owners did not have gardens).

The number of households at a property and type of pit latrine in use

Several researchers have examined factors affecting the adoption of ecological sanitation and have identified the cost of the technology, education status, occupation, religion and age as key factors affecting the adoption of the technology (Tumwebaze & Niwagaba, 2011; Uddin, et al., 2012). However, none of these studies identified the type of pit latrine in use and number of households at a property as important indicators of lack of demand for ecological sanitation. Research has shown that property owners with

access to lined pit latrines compared to those without lined pit latrines are more likely to demand pit emptying services (Jenkins et al., 2015). The results confirm this observation. Property owners that had lined pit latrines compared to those that were using unlined pit latrines were 11.8 times more likely to select pit emptying services over ecological sanitation ($p < 0.001$). The results also showed that property owners that had multiple households at their properties (tenants) were more likely to select lined pit latrines over ecological sanitation (RRR=1.1, $p = 0.02$). The results suggest that the market share of ecological sanitation is likely to remain lower than the market share of lined pit latrines since many property owners (65%) have multiple households.

Effect of knowledge on technology adoption

Research about diffusion of innovation has shown that innovation decision process begins when an individual is exposed to an innovation's existence and gains an understanding of how it functions (Rogers, 1995). The results confirm that knowledge plays a significant role in the choices that consumers make. Sixty nine percent had knowledge of ecological sanitation and property owners that had prior knowledge of ecological sanitation were less likely to select all other sanitation technology options offered over ecological sanitation. Thus local organisations promoting alternative sanitation technologies should ensure that urban residents have adequate information about alternative sanitation technologies.

Effect of microfinance on sanitation technology choices

Research has shown that microfinance for sanitation enables poorer households to access sanitation and upgrade from unimproved sanitation to improved sanitation and other researchers have suggested that microfinance will increase the proportion of households adopting ecological sanitation (Donkor, 2008; Trémolet, 2013; Uddin, et al., 2012). The results presented in this chapter support the idea that access to microfinance would increase the adoption of ecological sanitation. The proportion of property owners that selected ecological sanitation increased from 13% to 32% when microfinance was offered. Most property owners that selected unimproved sanitation before they were offered microfinance for sanitation selected fossa alterna toilets (cheaper than urine diverting toilet) when microfinance was offered. This observation confirms the importance of offering a range of products at different prices so that poorer households

should also have an opportunity of gaining access to improved and sustainable sanitation (Cairncross, 2004).

Although microfinance significantly increased the proportion of property owners that had selected ecological sanitation, and improved sanitation in general, there were some property owners that still selected unimproved sanitation. It is unlikely that microfinance for sanitation will benefit all property owners. Property owners not able to access microfinance for sanitation to improve their sanitation would require other initiatives e.g. market-compatible subsidies, for example vouchers, rebates, and cash transfers to support them to adopt sustainable sanitation (WSP, 2004).

3.4 Conclusion and recommendations

This chapter examined the sanitation technology choices that property owners make or are likely to make when offered a range of sanitation technology options and microfinance for sanitation. The results suggest that that fewer property owners have intention to adopt ecological sanitation. The results also suggest that socioeconomic, demographic characteristics of property owners and microfinance for sanitation play a significant role in the choices that property owners make. To successfully support property owners and their tenants to gain access to sustainable sanitation, the design and promotion of alternative technologies should be sensitive to the socio economic and demographic characteristics of the target audience. However, without microfinance for sanitation, the promotion of alternative sanitation technologies will not significantly increase the proportion of urban residents gaining access to sustainable sanitation.

Bibliography

Abraham, B., Kakumbi, G. M., Alam, M. M., & Von Muench, E. (2011). *Alternative solutions for challenging environments: A look at UNICEF-assisted ecosan projects worldwide.* *http://www.wedc.lboro.ac.uk/resources/conference/35/Abraham-B-1220.pdf*.

Altaf, M. A., & Hughes, J. A. (1994). Measuring the Demand for Improved Urban Sanitation Services - Results of a Contingent Valuation Study in Ouagadougou, Burkina-Faso. *Urban Studies, 31*(10), 1763-1776. doi: 10.1080/00420989420081621

Bracken, P., Münch, E. V., & Panesar, A. R. (2009). *Tackling the urban waste and food crises simultaneously and sustainably - Examples from the Philippines and Burkina Faso*.

Cairncross, S. (2004). The case for marketing sanitation. http://wsp.org/UserFiles/file/af_marketing.pdf.

Donkor, O., Arthur, B. (2008). *"Use now, pay later", An innovative approach to increasing access to improved latrine facilities in Ghana*.

Haq, G., & Cambridge, H. (2012). Exploiting the co-benefits of ecological sanitation. *Current Opinion in Environmental Sustainability, 4*(4), 431-435. doi: 10.1016/j.cosust.2012.09.002

Hawkins, P., Blackett, I., & Heymans, C. (2014). The Missing Link in Sanitation Service Delivery: A Review of Fecal Sludge Management in 12 Cities. Washington, DC: WSP-World Bank Research Brief. http://www.wsp.org/.../WSP-Fecal-Sludge-12-City-Review-Research-Brief.pdf.

Hosmer, D. W., Lemeshow, S., Sturdivant, R. X. (2013). *Applied Logistic Regression*. Third edition. New Jersey: John Wiley & Sons.

Jenkins, M. W. (2004). Who Buys Latrines, Where and Why? http://wsp.org/sites/wsp.org/files/publications/af_latrines.pdf.

Jenkins, M. W., Cumming, O., & Cairncross, S. (2015). Pit Latrine Emptying Behavior and Demand for sanitation Services in Dar Es Salaam, Tanzania. *International Journal of Environmental research and Public Health, 2015*(12), 2588-2611.

Jenkins, M. W., Cumming, O., Scott, B., & Cairncross, S. (2013). Beyond 'improved' towards 'safe and sustainable' urban sanitation: assessing the design, management and functionality of sanitation in poor communities of Dar es Salaam, Tanzania. *Journal of Water, Sanitation and Hygiene for Development*

Moseti, Y., Kimani, S.,Mutua, B. (2009). *The linkage between settlement profile and choice of sanitation system in peri-urban areas: A case study of Nakuru municipality.* Paper presented at the Water, Sanitation and Hygiene: Sustainable Development and Multisectoral Approaches - Proceedings of the 34th WEDC International Conference.

Peal, A., Evans, B., Blackett, I., Hawkins, P., & Heym, C. (2014). Fecal sludge management (FSM): analytical tools for assessing FSM in cities. *Journal of Water, Sanitation and Hygiene for Development., 4*(3), 371-383.

Rogers, E. M. (1995). *Diffusion of Innovations*. 5th Edition. New York: Free Press.

Tadesse, S. (2011). *Sustainable EcoSan - Fossa alterna: The case of Menge, Ethiopia. http://wedc.lboro.ac.uk/resources/conference/35/Tadesse-S-1020.pdf*.

Thye, Y. P., Templeton, M. R., & Mansoor, A. (2011). A Critical Review of Technologies for Pit Latrine Emptying in Developing Countries. *Critical Reviews in Environmental Science and Technology, 41*(20), 1793-1819. doi: 10.1080/10643389.2010.481593

Trémolet, S. (2013). Sanitation microfinance: a solution to the household sanitation cash trap? http://www.shareresearch.org/NewsAndEvents/Detail/sanitation_microfinance_solution.

Tumwebaze, I. K., C. Luthi. (2013). Households' access and use of water and sanitation facilities in poor urban areas of Kampala, Uganda. *Journal of Water, Sanitation and Hygiene for Development 3* (2), 96-105.

Tumwebaze, I. K., & Niwagaba, C. B. (2011). *Ecological sanitation uptake, knowledge, beliefs and practices in Kabale Municipality, Kabale District. Retrieved from http://wedc.lboro.ac.uk/resources/conference/35/Tumwebaze-I-K-1266.pdf*.

Uddin, S., Muhandiki, V. S., Fukuda, J., Nakamura, M., & Sakai, A. (2012). Assessment of social acceptance and scope of scaling up urine diversion dehydration toilets in Kenya. *Journal of Water Sanitation and Hygiene for Development, 2*(3), 182-189. doi: 10.2166/washdev.2012.078

Uddin, S., Muhandiki, V. S., Sakai, A., Al Mamun, A., & Hridi, S. M. (2014). Socio-cultural acceptance of appropriate technology: Identifying and prioritizing barriers for widespread use of the urine diversion toilets in rural Muslim communities of Bangladesh. *Technology in Society, 38*(0), 32-39. doi: http://dx.doi.org/10.1016/j.techsoc.2014.02.002

WSP. (2004). Making toilets more affordable for the poor through microfinance: Lessons learned from introducing microfinance loans for sanitation in rural Cambodia. http://wsp.org/sites/wsp.org/files/publications/WSP-Learning-Note-Toilets-Through-Microfinance-Cambodia.pdf. *WSP - Learning Note*.

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I developed interview guides, developed research questionnaires, analysed the data and drafted the manuscript.

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CHAPTER 4

SANITATION TECHNOLOGY CHOICES WHERE THERE IS CONCERN ABOUT SPACE FOR REPLACING PIT LATRINES

SANITATION TECHNOLOGY CHOICES WHERE THERE IS CONCERN ABOUT SPACE FOR REPLACING PIT LATRINES

Abstract

This chapter examines the extent of the problem of availability of space for replacing pit latrines and whether concern about space for replacing pit latrines is associated with intention to adopt ecological sanitation. Data were collected from two cities in Malawi through a stated preference survey which targeted 1,300 property owners from 27 low-income and high population density urban settlements. Survey respondents were offered a range of sanitation technologies plus a pit emptying service. The results show that 75% of the property owners were not concerned about space for replacing pit latrines while 25% were concerned about space for replacing pit latrines. Concern about space for replacing pit latrines was associated with high number of houses/households at a property, lack of access to lined pit latrines, lack of vacant space at a property and concern about high groundwater table. Property owners with high level of concern about space for replacing pit latrines were more likely to select pit emptying service over construction of new pit latrines with slab/cement floor (RRR 1.2, $p = 0.04$). The results also show that property owners with high level of concern about space for replacing pit latrines were more likely to select Fossa alterna toilets, the cheaper type of ecological sanitation over construction of unlined pit latrines (RRR=1.2, $p = 0.05$). However, there was no association between high level of concern and bout space for replacing pit latrines and intention to adopt Urine diverting toilets (expensive type of ecological sanitation). The results suggest that unless alternative sanitation technologies are affordable, property owners are less likely to gain access to sustainable sanitation through the adoption of alternative sanitation technologies.

4. Introduction

Chapter 3 offered useful insights about sanitation technology choices property owners make or are likely to make when they are offered a range of sanitation options plus microfinance for sanitation. However, the chapter did not provide information about sanitation technology choices property owners make or are likely to make where there is concern about space for pit replacing pit latrines.

In Southeastern Africa, one of the key challenges facing urban residents is finding space for replacing pit latrines when they fill up[10] (Collender, 2011; Isunju et al., 2011). The promotion of ecological sanitation is therefore seen as an important strategy for supporting urban residents to gain access to sustainable sanitation and maintain access to sanitation where there is concern about space for replacing pit latrines (Abraham, et al., 2011; Morgan & Mekonnen, 2013). Although ecological sanitation is considered to be a key solution where there is concern about space for replacing pit latrine, there is no empirical evidence to suggest that property owners in low-income and high population density urban areas adopt or intend to adopt ecological sanitation where there is concern about space for pit latrines.

To guide the development of urban sanitation policies and investment plans aimed at supporting urban residents to gain access to sustainable sanitation, it is imperative that policy makers and sanitation managers fully understand the sanitation technology choices that property owners make or are likely to make where there is concern about space for replacing pit latrines: do they seek to adopt ecological sanitation? Or do they prefer to continue with pit latrines and demand pit emptying services? This chapter therefore sets out to examine the extent of the problem of availability of space for replacing pit latrines and whether concern about space for replacing pit latrines is associated with intention to adopt ecological sanitation.

[10] This refers to a situation where there is no space for the property owner to continue the practice of building new facilities and abandoning them when they fill up.

4.1 Materials and methods

Data collection and analysis

Data were collected from Lilongwe and Blantyre City. A range of sanitation technology options plus a pit emptying service option were offered to 1,300 property owners from 27 low-income and high population density urban areas as described in chapter 2. The data were collected through a semi-structured questionnaire. The questionnaire captured the following data: type of pit latrine in use, socioeconomic and demographic characteristics of property owners, level of concern about space for replacing pit latrines and sanitation technology choices. Concern about space for replacing pit latrines was examined using a 4 point likert scale (1=not concerned, 2=little bit concerned, 3=concerned and 4= very concerned).

Data were entered into EpiData version 3.1 and transferred into Stata version 12 for analysis. Frequencies were calculated to examine the proportion of property owners concerned about space for replacing pit latrines and their sanitation technology choices. Socioeconomic and environmental conditions associated with concern about space for replacing pit latrines were examined using ordered logistic regression. Multinomial logistic regression models were developed to examine the likelihood of selecting ecological sanitation. Unlined pit latrines were selected as the reference category as they are the most common form of sanitation. A series of univariable analyses were conducted to select variables to include in the regression models. Variables that had a p-value of 0.20 or less were selected for inclusion in the models.

4.2 Results

4.2.1 Who is concerned about space for pit latrines?

The descriptive statistics of the sampled property owners has been presented on chapter 3. When asked about concern about space for replacing pit latrines, 75% (971) indicated that they were not concerned while 3% (41) were little bit concerned, 6% (80) were concerned and 16% (208) were very concerned about availability of space for replacing pit latrines. Concern about space for replacing pit latrines was

associated with the number of households at a property, lack of vacant space, use of unlined pit latrines and high concern about high groundwater table (table 4.1).

Table 4.1: Conditions associated with concern about space for pit latrines (n=1248)

Variable	*n*	OR	p-value	95% Conf.int
Number of households at the property		1.1	0.004	1.0 - 1.2
Availability of vacant space at the property				
Yes (ref)	503			
No	745	3.5	0.00	2.7 - 4.6
Concern about high groundwater table		1.2	0.01	1.0 - 1.3
Concern about shallow bedrock		1.0	0.53	0.9 - 1.1
Type of current pit latrine				
Lined pit latrine (ref)	227			
Unlined pit latrine	658	2.5	0.00	1.7 - 3.6
Unimproved sanitation (mud floor)	363	1.9	0.01	1.2 - 2.9
Income status of property owner				
>MK40,000 (ref)	410			
<MK20,000	405	1.1	0.70	0.8-1.5
MK20,000 - MK40,000	433	1.0	0.90	0.7-1.3

Note: Results from ordered logistic regression. Data exclude property owners with pour flush (1), ecological sanitation (32) and no sanitation facilities (19). LR chi2 (9) = 125.5, probability >chi2 = 0.000, Pseudo R-squared = 0.06

4.2.2 Technology choices where there is concern about space

Sanitation technology choices of property owners that were concerned about space for replacing pit latrines are shown on figure 4.1. Before microfinance was offered, 7% of property owners concerned about space for replacing pit latrines selected urine diverting toilets and 9% selected Fossa alterna toilets. After microfinance was offered, 16% of property owners concerned about space selected Urine diverting toilets and 19% selected Fossa alterna toilets. The results suggest that access to microfinance would significantly increase the adoption of ecological sanitation among property owners concerned about space for replacing pit latrines.

Figure 4.1: Technology choices of property owners concerned about space (n=316)

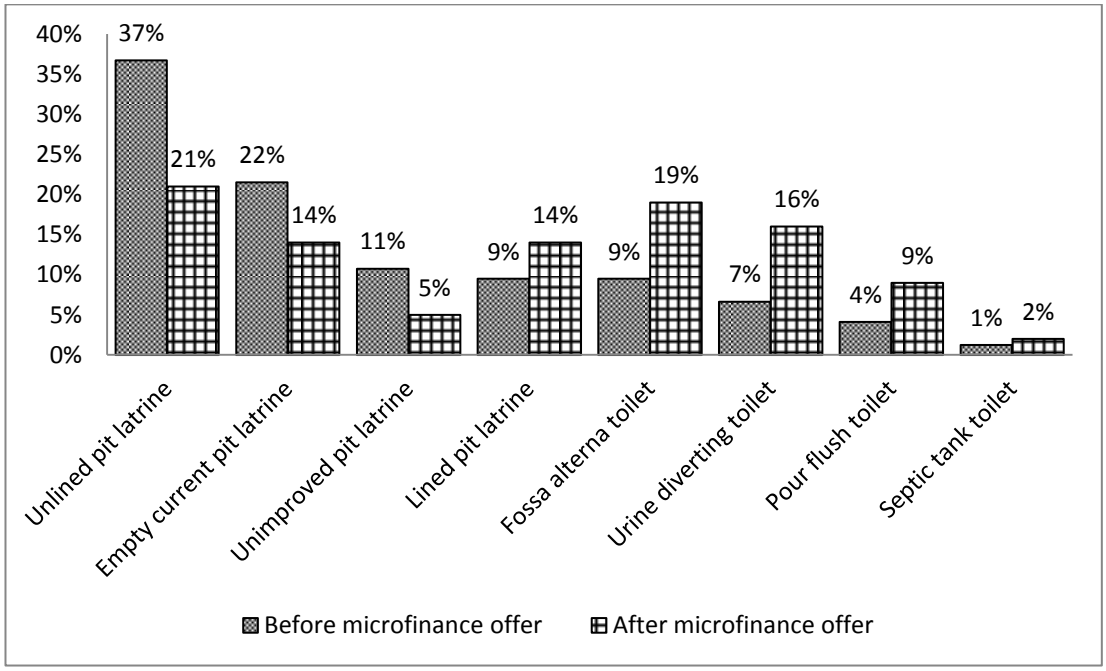

Table 4.2 shows the likelihood of selecting ecological sanitation where there is concern about space for replacing pit latrines. The table shows a significant positive association between higher levels of concern about space for replacing pit latrines and intention to adopt Fossa alterna toilets (cheaper type of ecological sanitation). The table also shows a significant positive association between high levels of concern about space for replacing pit latrines and intention to empty current pit latrines. However, there was no association between high levels of concern about space for replacing pit latrines and intention to adopt Urine diverting toilets (expensive type of ecological sanitation). The table also shows that property owners with high levels of concern about space for replacing pit latrines were less likely to select lined pit latrines over unlined pit latrines. Both lined pit latrines and unlined pit latrines are considered as solutions where there is concern about space for replacing pit latrines (discussed in chapter 5). However, lined pit latrines are more expensive than unlined pit latrines and this may explain why property owners concerned about space were less likely to select lined pit latrines.

Table 4.2: Likelihood of selecting ecological sanitation when there is concern about space for replacing pit latrines (n=1198)

Variable	n	Septic tank		Pour flush toilet		Urine diverting		Fossa alterna		Lined pit latrine		Unimproved sanitation		Empty current latrine	
		RRR	95% Conf. int	RRR	95% Conf. int	RRR	95% Conf. int	RRR	95% Conf. int	RRR	95% Conf. int	RRR	95% Conf. int	RRR	95% Conf. int
Concern about space for sanitation		0.9	0.6-1.5	1.0	0.7-1.3	1.0	0.8-1.3	1.2*	1.0-1.5	0.8*	0.7-1.0	0.9	0-7-1.1	1.2*	1.0-1.4
Income status of property owner															
MK>40,000 (ref)	402														
<MK20,000	396	0.1*	0.0-0.5	0.2***	0.1-0.4	0.5	0.3-1.0	0.6	0.3-1.0	0.5*	0.3-0.9	4.0***	1.9-8.5	0.3***	0.2-0.5
MK20,000 - MK40,000	419	0.2*	0.0-0.7	0.2***	0.1-0.4	0.5*	0.3-1.0	0.6	0.3-1.0	0.8	0.5-1.2	1.8	0.8-3.8	0.6*	0.4-0.9
Type of pit latrine in use															
Lined pit latrine (ref)	220														
Unlined pit latrine	633	0.02***	0.0-0.1	0.02***	0.0-0.2	0.02***	0.0-0.1	0.04***	0.0-0.2	0.01***	0.0-0.1	0.03***	0.0-0.3	0.002***	0.0-0.0
Unimproved sanitation	345	0.02***	0.0-0.3	0.02***	0.0-0.2	0.03***	0.0-0.2	0.1***	0.0-0.4	0.03***	0.0-0.2	1.5	0.2-11.1	0.001***	0.0-0.0
No sanitation facility	19	0.0	0.00	0.0	0.00	0.1*	0.0-0.7	0.1	0.0-1.0	0.04***	0.0-0.3	0.6	0.1-5.9	0.0	0.00
Number of households at property		0.8	0.6-1.1	1.0	0.8-1.1	1.0	0.9-1.1	1.0	0.9-1.1	1.1	1.0-1.2	1.0	0.9-1.1	0.9	0.8-1.0
Access to a garden															
No (ref)	806														
Yes	411	1.4	0.5-3.9	0.5	0.2-1.2	1.2	0.7-2.1	1.6*	1.0-2.7	1.1	0.7-1.7	1.3	0.8-2.0	0.8	0.5-1.2
Has piped water on the yard															
No (ref)	793														
Yes	424	1.6	0.6-4.8	2.3*	1.1-4.6	1.1	0.6-2.0	0.6	0.4-1.1	1.6*	1.1-2.5	0.6	0.3-1.1	0.8	0.5-1.2
Knowledge of ecological sanitation															
No (ref)	399														
Yes	818	0.5	0.2-1.4	0.6	0.3-1.2	2.6*	1.3-5.2	0.7	0.5-1.2	1.0	0.7-1.5	0.8	0.5-1.2	1.0	0.6-1.5
_cons		9.0*	1.0-83.5	8.7*	1.4-54.5	3.2	0.5-18.8	4.5	0.8-25.1	21.5	4.6-100.3	0.7	0.1-5.7	143.7	31.1-664.3

Notes: Results from multinomial logistic regression using unlined pit latrines as the reference category. The sample (n = 1217) excluded respondents with ecological sanitation (32), and pour flush (1) toilets. Data from 51 respondents were excluded because of inconsistency. ***p<0.001, *p<0.05
LR chi2 (70) =1009.1, probability >chi2 = 0.000, Pseudo R-squared =0.23

4.3 Discussion

This chapter examined the extent of the problem of availability of space for replacing pit latrines and whether concern about space for replacing pit latrines is associated with intention to adopt ecological sanitation. The choices property owners make or are likely to make where there is concern about space for replacing pit latrines have important implications on the development of alternative sanitation technologies and the nature of pit emptying services in low-income and high population density areas.

Characteristics of property owners concerned about space for pit latrines

When asked about availability of space for replacing pit latrines, 75% indicated that they were not concerned about space for replacing pit latrines while 25% were concerned about space for replacing pit latrines. The results showed that property owners that were using unlined pit latrines and unimproved sanitation compared to property owners that were using lined pit latrines were 2.5 times and 1.9 times more likely to be concerned about space for replacing pit latrines ($p < 0.001$, $p = 0.01$ respectively). The results also showed that a unit increase in the number of households at a property increased the odds of being concerned about space for replacing pit latrines (OR = 1.1, $p = 0.004$) and a unit increase in the level of concern about high groundwater table increased the odds of being concerned about space for replacing pit latrines (OR = 1.2, $p = 0.01$). The results further showed that property owners that did not have any vacant space compared to property owners that had vacant space within their properties were 3.5 times more likely to be concerned about space for replacing pit latrines ($p < 0.001$). These results suggest that the way property owners build their houses and pit latrines affect availability of space for replacing pit latrines. The results confirm the observation that lack of building regulations results in property owners building multiple houses at the expense of space for replacing pit latrines (Isunju, et al., 2011). Urban sanitation interventions should therefore not focus only on the development and promotion of alternative sanitation technologies and hygienic pit emptying services but also on regulating the number of houses property owners build to ensure that they are reserving enough space for replacing pit latrines. Urban sanitation interventions should also aim at supporting property owners to improve the build quality of pit latrines e.g. by lining

latrine vaults with bricks and cement. Lined pit latrines are less likely to collapse than unlined pit latrines and they offer property owners sanitation facilities that can be emptied (Jenkins et al., 2015).

Concern about space for pit latrines and microfinance for sanitation

When asked about their sanitation technology choices, 22% of property owners concerned about space for replacing pit latrines selected pit emptying service while only 9% selected Fossa alterna toilets and only 7% selected Urine diverting toilets. When microfinance was offered, 14% of property owners concerned about space selected pit emptying service while 19% selected Fossa alterna toilets and 16% selected Urine diverting toilets. These results support the observation that property owners concerned about space for replacing pit latrines compared to those not concerned are more likely to accept microfinance for sanitation (chapter 3).

The results suggest that even where there is concern about space for replacing pit latrines, many property owners prefer to install pit latrines over adoption of alternative sanitation technologies. However, improving access to microfinance for sanitation would significantly increase the proportion of alternative sanitation technologies among property owners concerned about space for replacing pit. The results support the idea that financial resources play a significant role in adaptation strategies people adopt (Kates, Travis, & Wilbanks, 2012). Thus efforts to support urban residents to gain access to sustainable sanitation should not focus only on the development and promotion of alternative sanitation technologies and hygienic pit emptying services, but also on improving access to microfinance for sanitation. Improving access to microfinance for sanitation to enable property owners adopt alternative sanitation technologies that allow users to start the process of treating human excreta (by adding ash and soil) is important considering that many city authorities across Africa do not have the infrastructure and financial resources to adequately treat faecal sludge (Peal et al., 2014).

Ecological sanitation when there is concern about space for pit latrines

Two types of ecological sanitation technologies were offered to survey respondents: Fossa alterna and Urine diverting toilets. Fossa alterna toilets were cheaper than Urine diverting toilets in the study areas but the promotion of ecological sanitation focuses on Urine diverting toilets. The results showed that property owners with high level of concern about space for replacing pit latrines were 1.2 times more likely to select Fossa alterna toilets over pit latrines with cement floor ($p = 0.04$) but there was no association between high level of concern about space for replacing pit latrines and intention to adopt Urine diverting toilets. The results support the observation made by Cairncross (2004), who indicated that sanitation consumers are often offered expensive products which are not affordable. The results suggest that unless alternative sanitation technologies are affordable, the promotion of alternative sanitation technologies will not significantly increase the proportion of urban residents gaining access to sustainable sanitation.

4.4 Conclusion and recommendations

Concern about space for replacing pit latrines arise when property owners build multiple houses, fail to reserve adequate space and use unlined pit latrines. High ground water table is also a key cause of concern about space for replacing pit latrines. Where there is concern about space for replacing pit latrines, property owners are more likely to consider adopting Fossa alterna toilets as a solution than Urine diverting toilets which are more expensive. The results suggest that unless property owners have access to affordable alternative sanitation technologies and microfinance for sanitation, the promotion of alternative sanitation technologies will not significantly increase the proportion of urban residents gaining access to sustainable sanitation. To support urban residents gain access to sustainable sanitation, city authorities should not focus only on the promotion of alternative sanitation technologies, but also on regulating the number of houses property owners build to ensure that they are reserving enough space for replacing pit latrines.

Bibliography

Abraham, B., Kakumbi, G. M., Alam, M. M., & Von Muench, E. (2011). *Alternative solutions for challenging environments: A look at UNICEF-assisted ecosan projects worldwide.* *http://www.wedc.lboro.ac.uk/resources/conference/35/Abraham-B-1220.pdf*.

Cairncross, S. (2004). The case for marketing sanitation. http://wsp.org/UserFiles/file/af_marketing.pdf.

Collender, G. (2011). Urban sanitation: An unprecedented and growing challenge. *Waterlines, 30*(4), 289-291.

Isunju, J. B., Schwartz, K., Schouten, M. A., Johnson, W. P., & van Dijk, M. P. (2011). Socio-economic aspects of improved sanitation in slums: A review. *Public Health, 125*(6), 368-376.

Jenkins, M. W., Cumming, O., & Cairncross, S. (2015). Pit Latrine Emptying Behavior and Demand for sanitation Services in Dar Es Salaam, Tanzania. *International Journal of Environmental research and Public Health, 2015*(12), 2588-2611.

Kates, R. W., Travis, W. R., & Wilbanks, T. J. (2012). Transformational adaptation when incremental adaptations to climate change are insufficient. *Proceedings of the National Academy of Sciences, 109*(19), 7156-7161. doi: 10.1073/pnas.1115521109

Morgan, P., & Mekonnen, T. (2013). Paving The Way to Scaling Up: Factors contributing to the adoption of ecos-san toilets. http://shareresearch.org/.../morgan_and_mekonnen_2013_paving_the_way_to_scaling_up_ecosan.pdf.

Peal, A., Evans, B., Blackett, I., Hawkins, P., & Heym, C. (2014). Fecal sludge management (FSM): analytical tools for assessing FSM in cities. *Journal of Water, Sanitation and Hygiene for Development., 4*(3), 371-383.

Werner, C., Panesar, A., Rüd, S. B., Olt, C. U. (2009). Ecological sanitation: Principles, technologies and project examples for sustainable wastewater and excreta management. *Desalination, 248*(1-3), 392-401.

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I developed interview guides, developed research questionnaires, analysed the data and drafted the manuscript.

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CHAPTER 5

SANITATION TECHNOLOGY ADOPTION AND ADAPTATION IN LOW-INCOME URBAN AREAS

Figure 5.1: New pit dug on old latrine spot

Figure 5.2: UDT built close to a house

Figure 5.3: Pit latrine with a slab/cement floor

Figure 5.4: Lining pit with bricks (lined pit latrine)

SANITATION TECHNOLOGY ADOPTION AND ADAPTATION IN LOW-INCOME URBAN AREAS

Abstract

This chapter examines local adaptation strategies property owners in low-income and high population density urban areas adopt to address the limitations of pit latrines, particularly lack of space for their replacement: do they seek to adopt ecological sanitation, or do they adapt pit latrines to cope? Data were collected through 39 in-depth interviews (IDIs) which targeted mainly property owners. The results showed that concern about space for replacing pit latrines arise when property owners purchase relatively small plots, build multiple or bigger houses at the expense of space for sanitation and when they replace pit latrines frequently. Where there is concern about space for replacing pit latrines, property owners prefer to improve the build quality of pit latrines and change the way they operate and maintain them to adoption of ecological sanitation technologies which are expensive and require significant behaviour change. The adaptation strategies property owners implement are easier, cheaper to implement and are compatible with way property owners and their tenants have traditionally been building, operating and maintaining pit latrines. Sanitation technology experts and change agents should take time to understand adaptation strategies urban residents adopt to address the limitations of pit latrines as new ideas will be evaluated against existing adaptation strategies.

5. Introduction

Results from chapter four showed that only 16% of the property owners that were concerned about space for replacing pit latrines had intention to adopt ecological sanitation. This proportion increased to 35% when property owners were offered microfinance for sanitation. The results from chapter 4 suggest that the adoption of alternative sanitation technologies is not the main solution property owners adopt where there is concern about space for replacing pit latrines.

To guide urban sanitation policies and the development and promotion of alternative sanitation technologies that will support property owners and their tenants to gain access to sustainable sanitation, it is important that policy makers, sanitation managers and change agents fully understand adaptation strategies property owners adopt where there is concern about space for replacing pit latrines. The concept of adaptation originates from population biology and ecological sciences; applied to human systems, it may refer to a deliberate change in anticipation of or in reaction to external stress (Nelson et al., 2007). An analogous concept in systems engineering and infrastructure is *resilience*, or the ability of a complex system to adapt to change.

Research has shown that when there is threat to individual wellbeing, individuals are likely to see the need for change and can and do adapt to changing environmental circumstances based on their past experience, local knowledge and available resources (Eriksen et al., 2005; Smit & Wandel, 2006). To be successful, strategies that aim at supporting communities to respond to changing environmental conditions should be based on local knowledge and adaptation strategies communities implement to address their challenges (Eriksen et al., 2011). Commenting on the value of local knowledge, Rogers (1995) argued that a great deal of useful information is contained in indigenous knowledge systems and that by ignoring this knowledge, change agents introduce ideas that are unlikely to be successful.

The aim of this chapter is therefore to examine the causes of concern about space for replacing pit latrines and adaptation strategies property owners adopt where there is concern about space for replacing pit latrines. Data were collected through in-depth

interviews (IDIs) and focus group discussions (FGDs). The chapter discusses the implications of adaptation strategies alternative sanitation technologies.

5.1 Materials and methods

Study site, data collection and analysis

Data were collected from Lilongwe and Blantyre City. Respondents were selected using purposeful sampling and a series of in-depth interviews (IDIs) were carried out until additional interviews were not revealing new themes. In total, 39 property owners were interviewed. Respondents were asked the following key questions: (a) why do property owners run out of space for replacing pit latrines? (b) Are you concerned about space for replacing pit latrines? (c) How would you respond to the threat of running out of space for replacing pit latrines? (d) How do other people in this community respond to the threat of running out of space for replacing pit latrines? Information collected from property owners was triangulated with information from builders and hygiene promoters. In total, 27 hygiene promoters (6 male, 21 female) and 12 builders (11 male, 1 female) were interviewed. The builders and hygiene promoters were invited to attend focus group discussions (FGDs). Three FGDs were carried out. IDIs and FGDs were digitally recorded and manually transcribed in a word processor before subjecting transcripts to thematic analysis using Microsoft excel spreadsheets (chapter 2).

5.2 Results

5.2.1 Causes of concern about space for replacing pit latrines

The IDIs uncovered four key causes of concern about space for replacing pit latrines (table 5.1). The most frequently identified causes of concern were replacing pit latrines frequently, building multiple houses at the expense of space for pit latrines and purchasing relatively small plots due to lower disposable incomes.

Table 5.1: Causes of concern about space for replacing pit latrines (n=39)

Cause of concern about space	n	%
1. Replacing pit latrines frequently	22	54
2. Building multiple houses on relatively small plots	17	44
3. Purchasing relatively small plots	16	41
4. Building relatively big houses on small plots	5	13

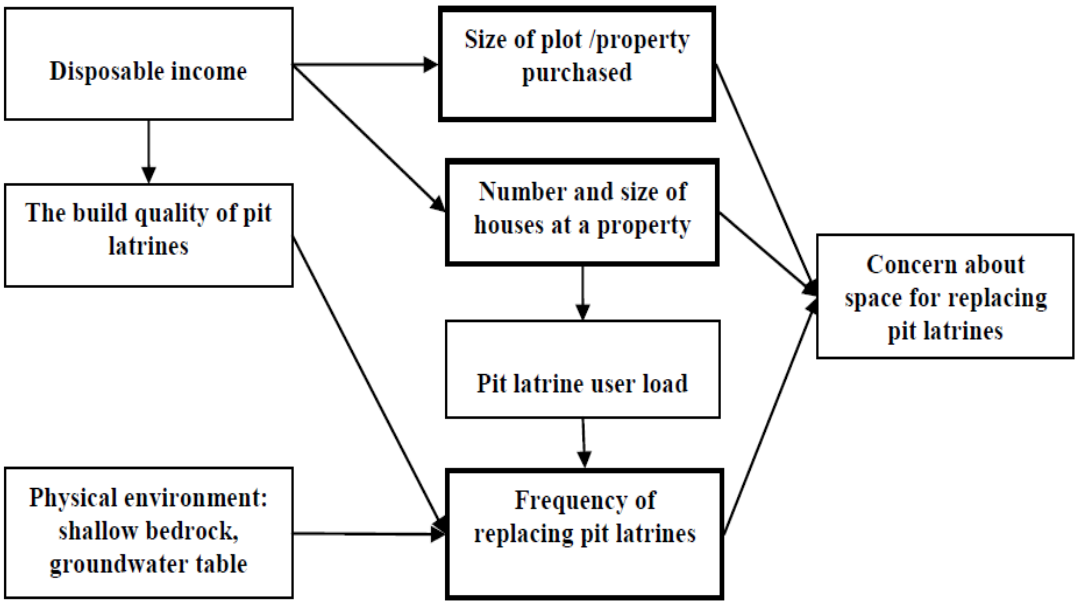
Source: In-depth interviews

Concern about space for replacing pit latrines arise when property owners replace pit latrines frequently – less than five years. This reason was explained by one respondent as follows: "People here just dig and construct latrines and they end up collapsing. Here people are not used to lining the chambers of their pit latrines. They see it as something that they cannot afford. It's like they prefer constructing a latrine today and another one tomorrow and then later on they find out that they have nowhere to construct a pit latrine." Another respondent explained the reason for replacing pit latrines frequently as follows: "due the problem of shallow bedrock; we end up digging shallow pits. As a result we construct new latrines almost every two years because it is difficult to dig deep as the ground is very hard." Property owners also identified high user load as a key reason why pit latrines are replaced frequently. This was explained by one property owner as follows: "the filling rate depends on the number of people, if there are many people it fills up fast but if there are fewer people, it takes longer to fill up. When we say that a toilet has been used for many years, we look at four to five years."

Concern about space for replacing pit latrines also arise when property owners build multiple houses or relatively big houses on small plots at the expense of space for replacing pit latrines. One respondent explained the following: "People take these plots as their business; they have small plots but they want to make money through rent so they leave small portions of their plots for replacing pit latrines." A property owner who did not want to run out of space for replacing pit latrines explained the

following: “I don’t want to build other houses because I don’t want to have many houses and later on have problems finding space for constructing new pit latrines.” The size of plots property owners purchase also leads to concern about space for replacing pit latrines – depending on the number of houses built. A property owner who felt that he had purchased a small plot explained the following: “Living here in town and living in your home village is different. Here we buy land, and we buy according to how much money we have. This is the only space I managed to buy so when this pit latrine fills up, I do not know what I will do.” Figure 5.5 summarises the cause of concern about space for replacing pit latrines.

Figure 5.5: Summary of factors causing concern about space for pit latrines.



5.2.2 Local adaptation strategies

Where there is concern about space for replacing pit latrines, property owners adopt five key adaptation strategies (table 5.2). These strategies include building replacement pit latrines on old pit latrine spots or bathroom spots, emptying pit latrines, improving the build quality of pit latrines to extend their lifespan, changing operational practices e.g. adding water into pit latrines and adopting alternative sanitation technologies (ecological sanitation).

Table 5.2: Adaptation strategies when there is concern about space (n=39)

Adaptation strategies	Number of respondents	%
(1) Identify alternative spaces for pit latrines		
Construct replacement pit latrine on old pit latrine spot	13	33
Construct replacement pit latrine on a bathroom spot	3	8
(2) Emptying pit latrines when they fill up	*10*	*26*
(3) Improving the build quality of pit latrines		
Build lined pit latrines	7	18
Digging deep pits	5	13
Roofing pit latrines	4	10
Avoid pit latrines without cement floor	3	8
(4) Changing operational practices		
Add water into pit latrines	8	21
Add chemicals into pit latrines	2	5
Add salt into pit latrines	1	3
(5) Adopting alternative sanitation technologies		
Adopt ecological sanitation	3	8

Source: in-depth interviews

The most frequently identified strategy was building replacement pit latrines on old pit latrine spots. One respondent explained this strategy as follows: "After some years if there is no any other space for a replacement pit latrine, we go back to old pit latrine spots. There is no problem because the faeces become like compost." However, this strategy has one key disadvantage as was explained by another respondent as follows: "when you go back to an old pit latrine spot, the pit latrine collapses." Alternatively, property owners build replacement pit latrines on bathroom spots as was explained by another respondent as follows: "some people pull down their bathroom and build replacement pit latrines on the bathroom spot and then change the full toilet into a bathroom." Other strategies include adding water, chemicals and salt into pit latrines. One respondent explained the advantage of adding water into pit latrines as follows: "I will direct water from the bathroom to go into the toilet. The faeces dissolve and the toilet takes many years before filling up, last time it took 12 years." Adoption of ecological sanitation was also identified as an

adaptation strategy. One adopter of ecological sanitation explained his decision for adopting the technology as follows: "We saw that our plot was small so we decided to build a facility that would allow us to use it for many years (ecological sanitation) so that we should no longer have trouble about space for replacing pit latrines." However, only 3 property owners (8%) identified the adoption of ecological sanitation as a strategy when there is concern about space for replacing pit latrines. In contrast, 33% mentioned building new pit latrines on old pit latrine spots, 18% mentioned lining latrine pits with bricks and 26% mentioned emptying pit latrines when they fill up. None of the property owners identified pour flush toilets or septic tank toilets as a technology they would install or other people install where there is concern about space for replacing pit latrines.

5.3 Discussion

Through a series on in-depth interviews (IDIs) this chapter examined factors that cause property owners in low-income and high population density urban areas to become concerned about space for replacing pit latrines and the adaptation strategies they implement to cope. The results showed four key causes of concern about space for replacing pit latrines and five key adaptation strategies. The causes of concern about space for replacing pit latrines and the adaptation strategies property owners implement have important implications on the promotion of alternative sanitation technologies and the nature of pit emptying services property owners require.

Concern about space for pit latrines and local adaptation strategies

Concern about space for replacing pit latrines arise when property owners purchase relatively small plots, build multiple houses at the expense of space for sanitation and replace sanitation facilities frequently – less than five years. Where there is concern about space for replacing pit latrines, property owners adopt a range of strategies.

The results suggest that where there is concern about space for replacing pit latrines, property owners prefer to change the way they build replacement pit latrines and change the way they operate and maintain pit latrines to adoption of ecological sanitation. Adoption of ecological sanitation was identified as a solution where there

is concern about space for replacing pit latrines. However, only 8% (3) identified the adoption of ecological sanitation as a strategy they would implement or as a strategy that other property owners implement where there is concern about space for replacing pit latrines. In contrast, 26% (10) identified pit emptying as a key strategy property owners implement and 33% (13) identified building replacement pit latrines on old pit latrine spots as the strategy property owners implement when there is concern about space for replacing pit latrines. This suggests that the adoption of ecological sanitation is not an established solution property owners adopt where there is concern about space for replacing pit latrines. The results support the idea that individuals are likely to adapt to changing conditions through behavioural adjustment than through the adoption of new technologies (Smithers & Smit, 1997).

As discussed in chapter four, the adoption of ecological sanitation requires people to completely change their behaviour in the way they build, operate and maintain sanitation facilities. Kates et al (2012) argued that it is easier to adapt to changing conditions through incremental behavioural adjustment than complete transformation which requires effort and adequate financial resources. The strategies property owners implement are easier and cheaper to implement and are compatible with the way property owners and their tenants have traditionally been operating and maintaining pit latrines than the adoption of ecological sanitation.

One of the key adaptation strategies property owners implement where there is concern about space for replacing pit latrines is building replacement pit latrines on old pit latrine spots or on bathroom spots. By building replacement pit latrines on old pit latrine spots, many property owners are already emptying their pit latrines without requiring sophisticated faecal sludge emptying technology or alternative sanitation technologies that need frequent emptying - as is the case with ecological sanitation. The vaults/pits of ecological sanitation facilities are emptied 6 to 12 months after closing them depending on the number of users (Morgan & Mekonnen, 2013). In contrast, the average lifespan of pit latrines in Malawi is 3.9 years (MIWD, 2008). Thus property owners that construct replacement pit latrines on old pit latrine spots wait for several years before emptying and handling human excreta.

Although urban residents have a range of adaptation strategies where there is concern about space, sanitation strategies in low-income and high population density urban areas focus on promotion of alternative sanitation technologies and improvement in the collection, treatment and disposal of human excreta (Thye et al., IWA, 2014; 2011). These strategies are necessary but they do not address the needs of property owners that empty their pit latrines by digging them up several years after they fill up. Sanitation strategies for low-income urban areas should also focus on the collection, treatment and disposal of soil from old pit latrines. City authorities should explore how the practice of constructing replacement pit latrines on old pit latrines spots or on bathrooms can be enhanced and be made safe to protect human health.

Efforts to address the limitations of pit latrines in low-income and high population density urban areas focus on technological solutions. Several researchers have explained that dependence on technological solutions does not address the root causes of undesired change (Fazey et al., 2010; Kelly & Adger, 2000). Sustainable solutions must also aim at addressing the underlying causes of undesired change (Kelly & Adger, 2000). Key underlying causes of concern about space for replacing pit latrines are that property owners prefer to build multiple houses or bigger houses at the expense of space for replacing pit latrines and they replace pit latrines frequently. Therefore, other than focusing on the promotion of alternative sanitation technologies and improving pit emptying services; city authorities should consider enforcing building regulations, particularly among new urban residents or those that still have vacant space to ensure that adequate space is being reserved for replacing pit latrines. Results from chapter four showed that 75% had vacant space and could construct new houses. Thus city authorities still have an opportunity to influence the way property owners build houses to ensure that enough space is being reserved for the replacement of pit latrines. This is important considering the fact that many city authorities in low-income countries do not have the equipment, infrastructure and financial resources to safely collect and treat faecal sludge (Peal et al., 2014)

5.4 Conclusion and recommendations

Concern about space for replacing pit latrines arise when property owners replace pit latrines frequently and when they build multiple houses at the expense of space for sanitation. Where there is concern about space for replacing pit latrines, property owners prefer to adapt by changing the way they build, operate and maintain pit latrines to the adoption of alternative sanitation technologies. Local adaptation strategies are easier, cheaper and compatible with the way property owners have traditionally been operating and maintaining sanitation facilities. To support property owners and their tenants to gain access to sustainable sanitation, policy makers, city authorities and sanitation technology experts should consider the following: (1) regulating the number and size of houses property owners construct to ensure that they are reserving enough space for replacing pit latrines, (2) supporting property owners to maximise the use of available space by designing bathing rooms and pit latrines in such a way that property owners can easily swap the locations of these two facilities (3) offering property owners affordable sanitation technologies, (4) increasing investment in hygienic pit emptying services.

Bibliography

Eriksen, S., Aldunce, P., Bahinipati, C. S., Martins, R. D., Molefe, J. I., Nhemachena, C., et al. (2011). When not every response to climate change is a good one: Identifying principles for sustainable adaptation. *Climate and Development, 3*(1), 7-20.

Eriksen, S. H., Brown, K., & Kelly, P. M. (2005). The dynamics of vulnerability: Locating coping strategies in Kenya and Tanzania. *Geographical Journal, 171*(4), 287-305.

Fazey, I., Gamarra, J. G. P., Fischer, J., Reed, M. S., Stringer, L. C., & Christie, M. (2010). Adaptation strategies for reducing vulnerability to future environmental change. *Frontiers in Ecology and the Environment, 8*(8), 414-422.

IWA. (2014). Faecal Sludge Management, systems approach for implementation and operation. http://www.unesco-ihe.org/faecal-sludge-management-0.

Kates, R. W., Travis, W. R., & Wilbanks, T. J. (2012). Transformational adaptation when incremental adaptations to climate change are insufficient. *Proceedings of the National Academy of Sciences, 109*(19), 7156-7161.

Kelly, P. M., & Adger, W. N. (2000). Theory and Practice in Assessing Vulnerability to Climate Change and Facilitating Adaptation. *Climatic Change, 47*(4), 325-352.

Morgan, P., & Mekonnen, T. (2013). Paving The Way to Scaling Up: Factors contributing to the adoption of ecos-san toilets. http://shareresearch.org/.../morgan_and_mekonnen_2013_paving_the_way_to_scaling_up_ecosan.pdf.

MIWD. (2008). The National Sanitation Policy, Malawi Government. http://www.ircwash.org/sites/default/files/842-MW06-19182.pdf.

Nelson, D. R., Adger, W., & Brown, K. (2007). Adaptation to Environmental Change: Contributions of Resilience Framework. *Annual Review of Environment and Resources, 32*, 395-419.

Ritchie, J. E., Lewis, J. (eds). (2003). Qualitative Research Practice: A Guide for Social Scientist Researchers. London: SAGE.

Rogers, E. M. (1995). *Diffusion of Innovation*s. 5th edition. New York: Free Press.

Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change-Human and Policy Dimensions, 16*(3), 282-292.

Smithers, J., & Smit, B. (1997). Human adaptation to climatic variability and change. *Global Environmental Change, 7*(2), 129-146.

Thye, Y. P., Templeton, M. R., & Mansoor, A. (2011). A Critical Review of Technologies for Pit Latrine Emptying in Developing Countries. *Critical Reviews in Environmental Science and Technology, 41*(20), 1793-1819.

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I developed interview guides, developed research questionnaires, analysed the data and drafted the manuscript.

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CHAPTER 6

WHEN PIT EMPTYING SERVICE FEES INCREASE; ITS EFFECT ON DEMAND FOR PIT EMPTYING SERVICES & ADOPTION OF ECOLOGICAL SANITATION

Figure 6. 1: Pit latrine being emptied

Figure 6. 2: Man with a gulper

Figure 6. 3: Getting paid after emptying

Figure 6. 4: Gulper on a motor bike.

WHEN PIT EMPTYING SERVICE FEES INCREASE; ITS EFFECT ON DEMAND FOR PIT EMPTYING AND ALTERNATIVE SANITATION TECHNOLOGIES

Abstract

This chapter examines the effect of increasing pit emptying service fees on demand for pit emptying service and ecological sanitation. Data were collected through a stated preference survey which targeted 650 property owners from 13 low-income and high population density areas in Blantyre City. At a pit emptying service fee of MK10, 000, fifty six percent of the property owners selected pit emptying service and only 6% selected ecological sanitation. When pit emptying service fees increased to MK20, 000, the proportion of property owners that selected pit emptying service decreased by 50% and the proportion of property owners that selected ecological sanitation increased to 11%. Property owners that were using lined pit latrines were less responsive to the pit emptying price increase compared to property owners that were using unlined pit latrines and unimproved sanitation. The most frequently identified reason for selecting pit emptying service over adoption of ecological sanitation or construction of new pit latrines were that emptying was cheaper and that the quality of the pit latrine in use was too good to pull it down and build another one. The results suggest that the cost of emptying pit latrines and the quality of pit latrine in use play a significant role in the sanitation technology choices property owners make and that an increase in pit emptying service fees would reduce demand for pit emptying service and influence property owners to seek alternative sanitation technologies. As cities rapidly urbanise, the level of investment for hygienic pit emptying services and the design and promotion of alternative sanitation technologies should be informed by these observations.

6. Introduction

In low-income and high population density urban areas, space for replacing pit latrines may not always be available and emptying pit latrines is challenging due to lack of access roads, unsatisfactory pit emptying equipment and poor design of pit latrines. The promotion of ecological sanitation and hygienic pit emptying services are seen as important strategies for supporting urban residents to gain access to sustainable sanitation (Morgan & Mekonnen, 2013; Thye et al., 2011). Hygienic pit emptying services allow urban residents to safely empty and dispose human excreta while alternative sanitation technologies such as ecological sanitation offer urban residents sanitation facilities that are permanent and easier to empty (Abraham et al., 2011; Morgan & Mekonnen, 2013; Thye et al., 2011). The promotion of hygienic pit emptying services and ecological sanitation offer property owners two competing strategies for maintaining access to sanitation and gaining access to sustainable sanitation. These strategies have important implications on demand for pit emptying services and the nature of pit emptying services to be offered to urban residents. It is important that policy makers and sanitation mangers understand the reasons property owners prefer to empty their pit latrines over the adoption of ecological sanitation and the dynamics between demand for pit emptying and ecological sanitation.

This chapter sets out to examine the reasons property owners prefer to empty their pit latrines to construction of new pit latrines or the adoption of ecological sanitation and the effect of increasing pit emptying service fees on intention to empty pit latrines or adopt ecological sanitation. Data were collected through a stated preference survey in Blantyre City. Property owners were offered a range of sanitation options including pit emptying service, ecological sanitation, lined pit latrines, pit latrines with cement floor, unimproved sanitation, pour flush and septic tank toilets. In addition, property owners were offered a lower and higher pit emptying service fee. The chapter discusses the implications of an increase in pit emptying service fees on demand for pit emptying services and alternative sanitation technologies.

6.1 Materials and methods

Data collection and study site

Data were collected from Blantyre City only. A two stage sampling technique was used to select 650 survey respondents (property owners) from 13 low-income and high population density urban areas as described in chapter 2. Survey respondents in the city were offered pit emptying services using a Gulper (appendix 1 and 2) at two different prices. First at MK10, 000 and then lastly at MK20, 000. At each price, property owners were asked to indicate whether they would empty their sanitation facility or construct another sanitation facility. In this city, Water for People – an international non-governmental organisation has introduced ecological sanitation and pit emptying services using a Gulper. At the time of the study, there were 2 entrepreneurs with Gulpers. These Gulpers were provided to the individuals free of charge. At the time of the survey, individuals with Gulpers were emptying faecal sludge into 200 litre drums which were then being carried on pick-up trucks to wastewater treatment stations. However, the faecal sludge was also sometimes buried in pits within the customer's property. The total cost for emptying a pit latrine depended on the number of drums emptied. At the time of data collection, emptying one drum was costing MK5, 000 and most households were emptying about 4 drums.

6.2 Results

Sample description

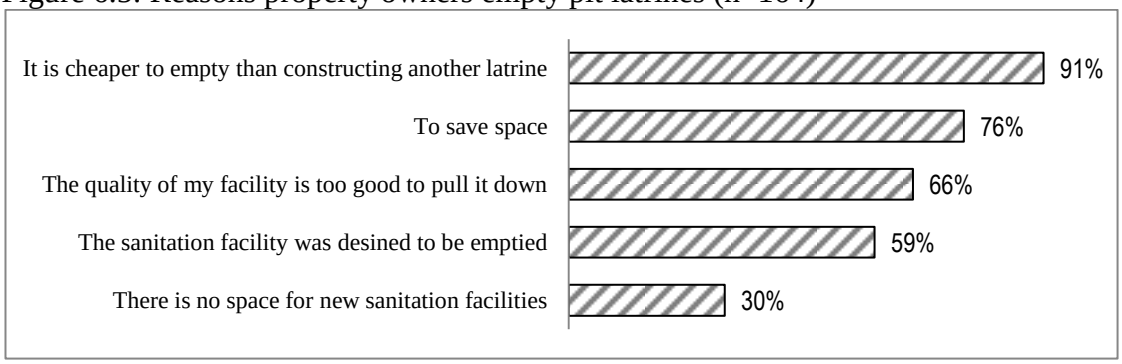
Access to sanitation was high, 34% (223) of the properties were using unlined pit latrines, 32% (209) were using unimproved sanitation and 28% (188) were using lined pit latrines. Only 2% (16) were using Urine diverting toilets. There were no Fossa alterna toilets in Blantyre City. Pour flush toilets were rare as only 1 property owner was using a Pour flush toilet. Two percent (13) did not have any sanitation facility but they claimed that they were using their neighbours' facilities. When asked whether they had emptied their pit latrines before, 92% indicated that they had never emptied before, 2% (11) had emptied their pit latrine before using a Gulper and

another 2% had emptied before, using a vacuum tanker while 4% (28) indicated that they had emptied their pits manually.[11]

6.2.1 Reasons property owners empty pit latrines

Figure 6.5 summarises the reasons property owners prefer to empty pit latrines over construction of new pit latrines or adoption of ecological sanitation. The most frequently identified reason for emptying pit latrines was that emptying current pit latrine was cheaper than construction of another sanitation facility (91%). Other reasons were to save space, the quality of the pit latrine is too good to pull it down and the pit latrine was designed to be emptied. Lack of space for replacing pit latrines was identified as a reason for emptying by fewer property owners (30%).

Figure 6.5: Reasons property owners empty pit latrines (n=164)



Notes: Data from only respondents that selected pit emptying service in Blantyre City

6.2.2 Price elasticity of demand for pit emptying services

Table 6.1 compares choices property owners made at a lower and higher pit emptying service fee. When pit emptying service fees increased from MK10, 000 to MK20, 000, the proportion of property owners that preferred to empty their current pit latrine decreased by 50%. Among property owners that were using unlined pit latrines, 124 preferred to empty their current pit latrine when the pit emptying fee was MK10, 000 but when the fee increased to MK20, 000, only 29 preferred to empty their current pit latrine – this represents a price elasticity of - 0.77. Among property owners that were using lined pit latrines, 164 preferred to empty their pit

[11] This involves scooping faecal sludge or digging a hole next to the full pit and connecting the full pit to the empty pit to desludge through gravity

latrines at MK10, 000 but when the fee increased to MK20, 000, a total of 131 preferred to empty their lined pit latrines - this represents a price elasticity of - 0.20. Property owners that had lined pit latrines were less responsive to the increase in pit emptying service fees than property owners that were using unlined pit latrines. With regard to property owners that were using unimproved sanitation, 38 preferred to empty their pit latrines at the pit emptying fee of MK10, 000 but when the fee increased to MK20, 000, only 3 property owners preferred to empty their unimproved pit latrines – this represents a price elasticity of - 0.92.

Table 6.1: Price elasticity of demand for pit emptying.

Sanitation technology in use	Emptying fee		Price elasticity
	MK10,000	MK20,000	
	n	*n*	
Unlined pit latrine	124	29	-0.77
Unimproved sanitation (mud floor)	38	3	-0.92
Lined pit latrine	164	131	-0.20
Total	326	163	-0.50

Note: Data excludes the sample from Lilongwe City

6.2.3 Case study

The case of Miss Neliya Kalilombe - a property owner from Blantyre City - confirms that property owners that have gained access to lined pit latrines are less responsive to an increase in pit emptying service fees. Miss Neliya Kalilombe has a lined pit latrine which was built in 2005 by her father. The pit latrine has two cubicles which are also used as bathrooms and wastewater from bathrooms flows into the pits. When the pit latrine filled up, Neliya decided to empty it. So she hired a contractor who emptied the pit latrine manually[12]. The contractor failed to empty all the sludge from the full pits using this methods but she still paid MK5, 000 ($11 at the time of the study) for the service. In June 2013, a research assistant met Neliya and explained several sanitation options that were available to her: ecological sanitation, emptying the full pit, building another lined pit latrine, pour flush toilet or a pit latrine with cement floor but not lined pit. Neliya was offered a pit emptying service at MK20,

[12] By digging a pit next to the full pit and connecting the full pit to the empty pit through a hole so that sludge should flow from the full pit into the empty pit.

000 ($50 at the time of study). After contemplating the options available to her; she decided to try emptying again. So she was linked to an entrepreneur with a gulper. When the entrepreneur visited Neliya, he felt that MK20, 000 was not enough to empty the facility as it had two cubicles so he charged MK30, 000 ($67 at the time of study). At an emptying fee of MK30, 000, Neliya felt that it was cheaper to empty her lined pit than adopting ecological sanitation or constructing another pit latrine.

6.2.4 Ecological sanitation when pit emptying fees increase

The proportion of property owners that selected pit emptying service significantly reduced when pit emptying service increased from MK10, 000 to MK20, 000 while the proportion of property owners that selected ecological sanitation increased significantly (table 6.2). At the lower pit emptying service fee, (4%) selected fossa alterna toilets and 2% selected Urine diverting toilets. Thus 6% selected ecological sanitation at the lower pit emptying service fee. When the service fees increased to MK20, 000, the proportion of Urine diverting toilets increased to 4% while the proportion of Fossa alterna toilets increased to 7%. Thus ecological sanitation increased to 11% from 6%. At the higher pit emptying service fee, the cost of emptying a pit latrine was closer to the cost of installing a Fossa alterna toilet; the cheaper version of ecological sanitation (MK30, 000 – MK50, 00) but at the lower pit emptying service fee, emptying was 3 to 5 times cheaper than fossa alterna.

Table 6.2: Technology choices at lower and higher pit emptying service fees.

Technology	Pit emptying fee			
	MK10,000		MK20,000	
	n	%	*n*	%
Unlined pit latrine	65	11%	131	22%
Unimproved sanitation	100	17%	113	19%
Lined pit latrine	53	9%	101	17%
Water based technologies		0%		0%
Pour flush toilet	3	1%	9	2%
Septic tank	6	1%	6	1%
Ecological sanitation				
Urine diverting toilet	12	2%	24	4%
Fossa alterna	23	4%	41	7%
Pit emptying	327	56%	164	28%
Total	589	100%	589	100%

Notes: Sample excludes respondents with ecological sanitation, those that had no sanitation facility and those whose choices were rejected because of data inconsistency.

6.3 Discussion

This chapter examined the reasons property owners prefer to empty their pit latrines to construction of new pit latrines or adoption of ecological sanitation and the effect of increasing pit emptying service fees on demand for pit emptying service and the adoption of ecological sanitation and. The results suggest that the type and quality of pit latrine in use and the cost of emptying pit latrines play a significant role in the choices that property owners make or are likely to make when pit latrines fill up.

Reasons property owners prefer to empty pit latrines

When property owners were asked about their sanitation technology choices in Blantyre City, 28% (164) selected pit emptying service over construction of new sanitation facilities including ecological sanitation while 72% (471) opted to construct new sanitation facilities. Property owners identified several reasons for selecting pit emptying service over construction of new sanitation facilities. The most frequently identified reason was that emptying was cheaper than construction of new sanitation facilities (91%). Other reasons for selecting pit emptying service were: to save space (77%) and the quality of the pit latrine is too good to pull down (66%). Lack of space for construction of pit latrines is often identified as the reason urban residents empty pit latrines (Radford & Fenner, 2013; Thye et al., 2011). The results showed that only 30% identified lack of space for pit latrines as a reason for emptying. The results suggest that lack of space for replacing pit latrines is not the most common reason property owners empty their pit latrines.

Effect of increasing pit emptying fees on adoption of ecological sanitation

Product/service prices play an important role in the choices of consumers (Mcpake, 2013). A study about pit emptying services in informal settlements in Uganda identified the cost of emptying pit latrines as a bottleneck to the removal and safe disposal of faecal sludge (Murungi & van Dijk, 2014). The results from this study confirmed that the cost of emptying pit latrines significantly affects pit emptying decisions. When the cost of pit emptying increased to MK20, 000 from MK10, 000, the proportion of property owners that selected pit emptying service reduced by 50%.

However, property owners that had lined pit latrines were less responsive to the price increase compared to property owners that were using unlined pit latrines. Research has shown that urban residents with lined pit latrines are likely to demand pit emptying service (Jenkins et al., 2014). These results suggest that the level of investment for hygienic pit emptying services should correspond to the proportion of property owners upgrading to lined pit latrines.

Other researchers have argued that city authorities should subsidise pit emptying service fees to make pit emptying service affordable (Murungi & van Dijk, 2014; Van Dijk, 2014). I argue against subsidising pit emptying services because demand for pit emptying would increase significantly yet many city authorities across Africa do not yet have the capacity to collect, treat and safely dispose faecal sludge (Peal, et al., 2014). Property owners not willing to pay the full market cost of pit emptying services should be offered alternative sanitation technologies that are affordable and easier and safer for users to empty e.g. fossa alterna toilets or sanitation facilities whose superstructures can be moved easily and reused (Morgan & Mekonnen, 2013; van Vuuren, 2008). Such facilities would allow property owners and their tenants to store human excreta on-site until the excreta are safer to handle. However, city authorities would still need to regulate the emptying of such facilities to ensure that the contents are safer to handle and are safely disposed or recycled.

When pit emptying service fees increased to MK20, 000, the proportion of ecological sanitation (urine diverting toilet, fossa alter) increased from 6% to 11%. At a higher pit emptying fee, the cost of emptying was closer to the installation cost of ecological sanitation (fossa alterna). This observation suggests that an increase in pit emptying service fees would influence property owners to seek alternative sanitation technologies that are easier and cheaper to empty. As urban population increase rapidly, city authorities should consider allocating adequate resources for the development and promotion of alternative sanitation technologies that are easier and safer for users to empty without the need for sophisticated pit emptying equipment.

6.4 Conclusion and recommendations

The quality of pit latrines in use and the cost of emptying pit latrines play a significant role in shaping people's decision regarding whether to empty their pit latrines, build another pit latrine or adopt alternative sanitation technologies. Property owners empty their pit latrines when they perceive that emptying is cheaper than construction of new pit latrines or adoption of alternative sanitation technologies. As cities rapidly urbanise, policy makers and city authorities should consider allocating adequate resources for developing and promoting alternative sanitation technologies and increasing investment in hygienic pit emptying services.

Bibliography

Abraham, B., Kakumbi, G. M., Alam, M. M., & Von Muench, E. (2011). *Alternative solutions for challenging environments: A look at UNICEF-assisted ecosan projects worldwide.* *http://www.wedc.lboro.ac.uk/resources/conference/35/Abraham-B-1220.pdf*.

Mcpake, B., Normand, C., Smith, S. (2013). *Health Economics: An international Economics.* Third edition, New York: Routledge.

Morgan, P., & Mekonnen, T. (2013). Paving The Way to Scaling Up: Factors contributing to the adoption of ecos-san toilets. http://shareresearch.org/.../morgan_and_mekonnen_2013_paving_the_way_to_scaling_up_ecosan.pdf.

Murungi, C., & van Dijk, M. P. (2014). Emptying, Transportation and Disposal of feacal sludge in informal settlements of Kampala Uganda: The economics of sanitation. *Habitat International, 42*, 69-75.

Peal, A., Evans, B., Blackett, I., Hawkins, P., & Heym, C. (2014). Fecal sludge management (FSM): analytical tools for assessing FSM in cities. *Journal of Water, Sanitation and Hygiene for Development., 4*(3), 371-383.

Radford, J. T., & Fenner, R. A. (2013). Characterisation and fluidisation of synthetic pit latrine sludge. *Journal of Water Sanitation and Hygiene for Development, 3*(3), 375-382.

Thye, Y. P., Templeton, M. R., & Mansoor, A. (2011). A Critical Review of Technologies for Pit Latrine Emptying in Developing Countries. *Critical Reviews in Environmental Science and Technology, 41*(20), 1793-1819. doi: 10.1080/10643389.2010.481593

Van Dijk, M. P., Etajak, S.,Mwalwega, B.,Ssempebwa, J. (2014). Financing sanitation and cost recovery in the slums of Dar es Salaam and Kampala. *Habitat International, 43*, 206-213.

van Vuuren, L. (2008). On-site sanitation challenges tackled through research. *Water Wheel, 7*(3), 32-33.

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I developed interview guides, developed research questionnaires, analysed the data and drafted the manuscript.

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SUPERVISOR/SENIOR AUTHOR'S SIGNATURE (3 above)

CHAPTER 7

DRIVERS OF DEMAND FOR ECOLOGICAL SANITATION & IT'S BARRIERS IN LOW-INCOME URBAN AREAS

Figure 7. 1: UDT front view

Figure 7. 2: UDT pipe for diverting urine into soak pit

.

Figure 7. 3: UDT with bucket for ash and soil

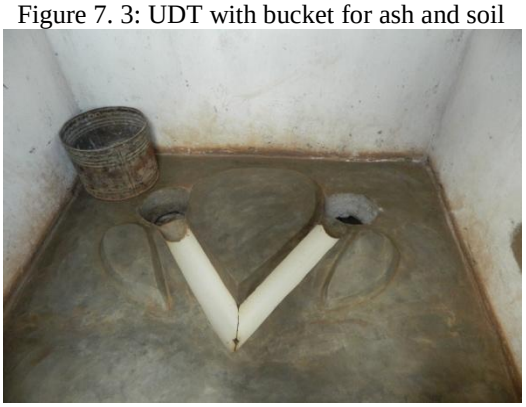

Figure 7. 4: Man inside UDT

DRIVERS OF DEMAND FOR ECOLOGICAL SANITATION IN LOW-INCOME & HIGH POPULATION DENSITY URBAN AREAS

Abstract

This chapter presents the results of a mixed methods research that examined the drivers of demand for ecological sanitation. Data were collected through 48 in-depth interviews and a stated preference survey which targeted a randomly selected representative sample of 650 property owners from 14 low-income and high population density urban areas in Lilongwe City. The results showed that nearly 100% of property owners liked the concept of ecological sanitation because it offers sanitation facilities that are designed to be emptied and reused (permanent facility) when they fill up, less likely to collapse and safer for children to use. However, the high installation cost of the technology, its incompatibility to users from multiple households and the inconvenience of emptying and handling recycled human excreta were its key adoption barriers. The results suggest that to reach scale, the design and promotion of alternative sanitation technologies should not focus on access to cheap fertiliser from recycled human excreta but on supporting urban residents to gain access to sanitation facilities that are permanent, easier to use and maintain and compatible with users from multiple households.

7. Introduction

This chapter is an extension of chapters three to six. Chapter three and four offered useful insights about the sanitation technology choices of property owners and the socioeconomic and demographic indicators of demand for ecological sanitation. Results from chapter four and five suggested that property owners prefer to address the limitations of pit latrines, particularly lack of space for their replacement by changing the way they build, operate and maintain pit latrines to adoption of ecological sanitation while chapter six showed that the quality of pit latrine in use and the cost of emptying pit latrines play a significant role in sanitation technology choices property owners make. Although these four chapters offered useful insights about the adoption of ecological sanitation in low-income and high population density urban areas, it was difficult to explain why property owners made the choices they made. For example, it was difficult to explain why wealthier property owners compared to poorer property owners were less likely to select ecological sanitation over pour flush toilets or why fewer property owners identified ecological sanitation as a solution where there was concern about space for replacing pit latrines.

This chapter uses perceptions and attitude of property owners to understand why the adoption of ecological sanitation in low-income and high population density urban areas has been very slow. People's perceptions and attitudes are found to be important when examining demand for innovation or new behaviour. As discussed by Rogers (1995), people's perceptions and attitude towards an innovation explain the complexity of adopting the innovation under investigation and offers technology experts and change agents useful information for product design and development. With regard to sanitation, Jenkins and Scott (2007) argued that people's attitudes about new sanitation options unlike socioeconomic indicators of demand, offer important information for developing effective marketing strategies.

The chapter is based on the theory of planned behaviour as discussed in chapter 2. Data were collected through mixed methods research, starting with a series of in-depth interviews followed by a stated preference survey which targeted property owners only. The chapter discusses key barriers affecting the adoption of the technology and strategies that could improve its adoption.

7.1 Materials and methods

7.1.1 Qualitative investigation

Data for this chapter were collected from Lilongwe City only. Data collection started with a series of in-depth interviews (IDIs) to explore the perceptions of urban residents towards ecological sanitation. A series of interviews were carried out until additional interviews were not contributing any new ideas and themes. The IDIs targeted 9 property owners and 6 tenants using urine diverting toilets (adopters) and 33 property owners using pit latrines (non-adopters), for a total of 48 IDIs. Property owners were the main respondents because they are the ones that usually make decisions regarding sanitation technology choices. Non-adopter property owners were asked the following three key questions: (1) what do you think about ecological sanitation? (2) What would motivate you to adopt it and what would stop you from adopting it? Information collected from property owners was triangulated with information collected from focus group discussions (FGDs) which targeted 3 groups of hygiene promoters and builders as discussed in chapter 5. The data were analysed using thematic analysis as discussed in chapter 2.

7.1.2 Stated preference survey

The in-depth interviews were followed by a stated preference survey. A two stage sampling technique was used to select 650 survey participants (property owners) from 14 low-income and high population density urban areas as described in chapter 2. Data were collected through a semi structured questionnaire (appendix 11). A list of 7 positive and 12 negative statements about ecological sanitation was developed from the IDIs. Survey respondents were asked to indicate whether they strongly agreed, agreed, disagreed or strongly disagreed with the statements. Survey respondents were also asked to indicate whether they strongly agreed, disagreed, or strongly disagreed to 3 statements which captured the influence of other people on the adoption of ecological sanitation. In Blantyre City, survey respondents were asked to evaluate fewer positive and negative statements about ecological sanitation (appendix 12). Results from Blantyre City were analysed separately (appendix 6).

The intentions of property owners to adopt ecological sanitation was examined by asking survey respondents to indicate what they would do when the facility they were using at the time of data collection fills up (empty or construct new facility). Those that indicated that they would construct a new sanitation facility were asked to select the technology they would construct. Property owners that selected Urine diverting toilets were considered to have intention to adopt Urine diverting toilets. Data collection focused on Urine diverting toilets as they (Urine diverting toilets) were the focus of organisations promoting sanitation in low-income urban areas in the study areas. The drivers of demand and barriers affecting the adoption of the technology were identified through multivariable binary logistic regression using intention to adopt Urine diverting toilet as the dependent variable and perceptions and attitude of survey respondents as explanatory variables. Factor analysis was used to reduce the positive and negative attributes of ecological sanitation to a smaller number of explanatory variables. The number of factors extracted was determined using eigenvalue greater than 1. Only items with factor loadings greater than 0.4 were selected using oblique rotation (Norman, 2000).

7.2. Results from the qualitative study

7.2.1 Positive attributes of ecological sanitation

Ecological sanitation has several positive attribute. Table 7.1 identifies six key positive attributes of the technology. The most frequently identified positive attributes were that ecological sanitation is permanent, it is easy to empty, it offers users access to cheap fertiliser from recycled human excreta and it does not smell.

Table 7.1: Positive attributes of ecological sanitation (n=48)

Positive attribute	*Number of respondents*	*%*
(1) It is permanent (designed to be emptied and reused)	29	60%
(2) Ecological sanitation is easier to empty than pit latrines	25	52%
(3) To access compost (cheap fertiliser) from human excreta	22	46%
(4) Ecological sanitation is less smelly compared to pit latrines	10	21%
(5) It is less likely to collapse compared to pit latrines	7	15%
(6) Ecological sanitation is safer for children to use	2	4%

Note: Results from in-depth interviews

Property owners liked the concept of ecological sanitation because it offers users permanent sanitation facilities compared to pit latrines. This attribute was explained by one respondent as follows: “The advantage of ecological sanitation is that it is for life, there will be no need to construct another sanitation facility.” Another property owner explained the advantage of ecological sanitation as follows: “it is forever - even your granddaughters and grandsons will use the same latrine.” Another important attribute of ecological sanitation is that it is easier to empty as was explained by one respondent as follows: “If it can be possible to empty the toilet yourself, then that would be okay. You may want someone to empty a pit latrine for you but it may take 3-4 days before the person comes to your house - so the toilet may spill over and the whole place can be unhygienic.” The ability to empty the technology offers users a financial benefit as was explained by one respondent as follows: “emptying pit latrines costs money and now things are becoming very expensive. By the time a pit latrine fills up, I may not have money for pit a pit emptying service.” Another key advantage of ecological sanitation is that it offers users access to cheap fertiliser from recycled human excreta. One adopter explained this advantage as follows: “These latrines are really helpful; today we don’t rely only on chemical fertilizer because we use compost from human excreta as fertiliser. I have used compost from human excreta as fertiliser three times and I get good and healthy maize from my garden.” However, access to compost from human excreta is unlikely to be appreciated by urban residents that do not have access to gardens for food crop production. One respondent explained the disadvantage of ecological sanitation as follows: “Here in town, we don’t have gardens where to grow crops compared to our home villages”. Another respondent explained the following: “I will be throwing away the compost; those that need it can collect it.” Property owners also liked the concept of ecological sanitation because it offers sanitation facilities that do not smell as was explained by one adopter as follows: “This latrine is good because it is odourless. We add a lot of ash and soil so it does not smell.

7.2.2 Negative attributes of ecological sanitation

Although ecological sanitation offers users several advantages, it has several negative attributes. Table 7.2 identifies four key negative attributes. The most frequently identified negative attributes were that ecological sanitation is too

involving to use compared to pit latrines, it is not compatible with users from multiple households and it is too expensive to install. Few respondents identified disgust with handling compost from human excreta as a negative attribute.

Table 7.2: Negative attributes of ecological sanitation (n=48)

Negative attribute	*Number of respondents*	*%*
1. Ecological sanitation is too involving to use	31	65%
2. It is not compatible with users from multiple households	18	38%
3. Ecological sanitation is too expensive to install	13	27%
4. Handling compost from human excreta is disgusting	5	10%

Note: Results from in-depth interviews

Property owners perceived ecological sanitation to be too involving to use. One hygiene promoter explained this challenge as follows: "This type of latrine on a plot where there are tenants only creates a lot of problems. In my area, a certain landlord constructed it for tenants to use but they don't use it the way it is supposed to be; they use it like a pit latrine - without adding ash or soil." Commenting on the difficulties of operating a Urine diverting toilet, one property owner explained her concern as follows: "Tenants say that it is too involving to be adding ash and soil. I will construct another pit latrine simply because my tenants say that they cannot manage to use ecological sanitation but I don't know how we are going to construct another pit latrine as there is a problem of space here." Another respondent who has observed the use of the technology at her mother's compound explained the following: "for these people (tenants) to manage the toilet, my mother struggles with them. We ask children to collect soil and ash." A tenant who had used ecological sanitation for several years explained the difficulties of using the technology follows: "I think ecological sanitation is not ideal where there are multiple households because people do not take care of the toilet. If the landlord allocates it to one household then I would accept to use it but not that all of us should use one ecological sanitation toilet - eee! It is too involving." One property owner explained the disadvantage of ecological sanitation as follows: "I am saying that one needs a pit latrine because ecological sanitation fills up in six months so if you have tenants, the latrine will fill up very quickly so it is better to build a pit latrine for tenants because with ecological sanitation, the facility will be filling up within six months."

Another key negative attribute of ecological sanitation is that it is expensive to install. A respondent who liked the concept of ecological sanitation explained the following: “For us, we are very interested with this type of toilet but our problem is money. These toilets are very helpful but we cannot afford these toilets because we need to also buy food and other things.” Property owners identified access to microfinance as a solution where affordability is a problem as was explained by one respondent as follows: “The main problem is lack of money because people don’t earn enough money and materials are very expensive. It would be better if there was an organization providing loans for these latrines.” With regard to disgust, few property owners (only 5) identified disgust with handling recycled human excreta as a negative attribute. One possible reason is that disgust may be primarily associated with handling other people’s faeces. One property owner who was liked the concept of ecological sanitation explained his position on disgust as follows: “In fact one would not need to hire someone - you can empty yourself because the faeces are yours, not someone else's. It's difficult when you are asked to empty someone's faeces; if it's your toilet, it cannot be disgusting.”

7.3 Results from the stated preference survey

The descriptive statistics of sampled property owners showed that 77% of the properties were owned by males and 23% were owned by females. Only 5% of the property owners did not have any education while 88% had primary and secondary education and 7% had college education. Access to sanitation was very high, with 67% (435) found to be using unlined pit latrines, 6% (39) using lined pit latrines, 2% (16) using ecological sanitation, 24% (154) using unimproved sanitation (pit latrines with mud floor) while 1% (6) did not have any sanitation facility. Sanitation facilities were shared at 66% of the properties. Knowledge about ecological sanitation was high with 69% reporting that they either had heard about or seen ecological sanitation. Access to gardens for food crop production was rare as only 22% (145) in the city had access to a garden.

7.3.1 Positive attributes of ecological

The perceptions of property owners towards the positive attributes of ecological sanitation are summarised on table 7.3. The table shows that nearly 100% of the property owners liked the concept of ecological sanitation because it offers users facilities that are designed to be emptied and reused (permanent facility), less likely to collapse and safer for children to use. However, many property owners (40%) did not perceive that access to cheap fertiliser from recycled human excreta – the key objective of ecological sanitation - was a motivating or important attribute.

Table 7.3: Positive attributes of ecological sanitation (n=616)

Positive attribute (motivating factors)	4 - point likert scale collapsed into binary response	
	Agree	Disagree
1. I would be motivated to adopt because it is permanent.	98%	2%
2. I would be motivated to adopt because it is safer for children.	98%	2%
3. I would be motivated to adopt because it will not collapse.	98%	2%
4. I would be motivated to adopt because it is less smelly.	93%	7%
5. I would be motivated to adopt because it is easier to empty	79%	21%
6. I would be motivated to adopt because it will make me look modern.	64%	36%
7. Access to compost from human excreta will motivate me to adopt.	60%	40%

Notes: results from the stated preference survey. Data excludes property owners with ecological sanitation and those whose data was excluded because of inconsistency

7.3.2 Negative attributes of ecological sanitation

Although nearly 100% liked the concept of ecological sanitation, only 14% (98) of the property owners in Lilongwe City had intention to adopt ecological sanitation. The installation cost, operation and maintenance challenges were the key barriers that prevented property owners from selecting ecological sanitation (table 7.4). Seventy one percent indicated that they could not afford to install urine diverting toilets, 33% indicated that the technology was not compatible with the number of people at their property, 20% indicated that handling compost from human excreta was disgusting and 18% indicated that the task of emptying the vaults of ecological

sanitation was too involving while 12% indicated that the task of adding soil and ash into the vaults of ecological sanitation was too involving.

Table 7.4: Negative attributes of ecological sanitation (n=616)

Negative attribute	4 - point likert scale collapsed into binary response	
	Agree	Disagree
1. The number of people on my plot would stop me from adopting.	33%	67%
2. I can afford a urine diverting toilet.	29%	71%
3. Handling compost from human excreta is disgusting.	20%	80%
4. The task of emptying the facility is too involving	18%	82%
5. The task of adding ash and soil is too involving.	12%	88%

Source: Stated preference survey

7.3.3 Influence of other people

The influence of other people is considered as an important factor associated with the adoption of new behaviour. The results suggest that there was little influence from other people as only 10% agreed that other people had told them to adopt ecological sanitation and only 9% agreed that hygiene promoters had told them to adopt ecological sanitation. The influence of builders was also not common as only 3% agreed that builders had told them to adopt ecological sanitation. Considering that many people (69%) had knowledge about the technology, the results suggest that urban residents are not recommending ecological sanitation to each other.

7.3.4 Socioeconomic characteristics and attitude towards ecological sanitation

The results showed differences in perceptions towards ecological sanitation between groups of property owners with different socioeconomic characteristics (table 7.5). Wealthier property owners compared to poorer property owners were 2.4 times more likely to indicate that they could afford ecological sanitation ($p < 0.001$). However, wealthier property owners compared to poorer property owners were 1.8 times more likely to indicate that the task of emptying ecological sanitation was too involving ($p = 0.03$) and that the task of adding soil and ash into the vaults of ecological sanitation

was too involving (OR =2.4, p = 0.01). The results on table 7.5 also show that property owners that were using shared sanitation compared to those not using shared sanitation were 5.3 times more likely to indicate that the number of people at their properties would stop them from adopting ecological sanitation ($p < 0.001$). The results further show that property owners that had prior knowledge of ecological sanitation compared to those without prior knowledge were less likely to indicate that handling compost from recycled human excreta was disgusting (OR = 0.5, $p < 0.001$) and that the task of emptying the facility was too involving (OR = 0.7, p=0.05). With regard to gender of property owners, the results show that male property owners compared to female property owners were more likely to indicate that they could afford to install ecological sanitation. With regard to access to gardens for food crop production, the results show that property owners that had gardens were 3.3 times more likely to indicate that access to compost from recycled human excreta was a motivating attribute ($p < 0.001$). The results from Blantyre city show similar differences between property owners with different socioeconomic and demographic characteristics (appendix 6).

Table 7.5: Characteristics of property owners less likely or more likely to adopt ecological sanitation (n=616)

Variable	n	Column1		Column 2		Column 3		Column 4		Column 5		Column 6	
		Access to compost from recycled human excreta will motivate me to adopt		Handling compost from recycled human excreta is disgusting		The task of emptying vaults is too involving		The task of adding ash and soil is too involving		I can afford to install urine diverting toilet		The number of people on my plot would stop me from adopting	
		Odds Ratio	95% Conf. int	Odds Ratio	95% Conf. int	Odds Ratio	95% Conf. int	Odds ratio	95% Conf. int	Odds ratio	95% Conf. int	Odds ratio	95% Conf. int
Access to a garden													
No access (ref)	483												
Had access	133	3.3***	2.1-5.2	1.1	0.7 -1.7	0.9	0.6-1.6	0.9	0.6-1.6	1.6*	1.0-2.3	0.9	0.6-1.3
Income status													
<MK20,000 (ref)	194												
MK20,000 - MK40, 000	204	1.1	0.7-1.6	1.2	0.7-2.0	2.03*	1.2-3.5	1.7	0.9 - 3.4	1.0	0.6-1.6	1.2	0.8-1.8
> MK40,000	218	0.9	0.6 - 1.3	1.1	0.7-1.9	1.8*	1.1-3.2	2.4*	1.2 -4.6	2.4***	1.6-3.7	1	0.7-1.5
Use of shared sanitation													
No shared sanitation (ref)	183												
Shared sanitation	433	1.0	0.7 -1.3	1.6*	1.0-2.4	1.5	0.9-2.3	1.1	0.6-0.8	0.7*	0.4-1.0	5.3***	3.4-8.5
Knowledge of ecosan													
No prior knowledge (ref)	199												
Had prior knowledge	414	1.5*	1.1-2.1	0.5*	0.3-0.8	0.7*	0.4-1.0	0.9	0.5-1.5	1.4	1.0-2.1	0.7	0.5-1.0
Gender of property owner													
Female (ref)	142												
Male	474	1.0	0.6 -1.4	0.7	0.4 -1.1	0.7	0.4-1.1	1.0	0.6-1.9	1.7*	1.1-2.7	0.8	0.5-1.2
Religion of property owner													
Christian (ref)	519												
Moslem	97	0.9	0.6-1.4	0.6	0.4-1.1	1.1	0.5-1.7	0.6	0.3-1.4	0.9	0.6-1.5	1.9*	1.2-2.9

Note: Results from univariable binary logistic regression. Data from 19 property owners excluded because of inconsistency, 16 property owners excluded from analysis as they had ecological sanitation. *p < 0.05, *** p <0.001

7.3.5 Factor analysis

Through factors analysis, 7 factors were extracted from the 22 statements that captured positive and negative attributes/perceptions towards ecological sanitation (table 7.6). The factor loading represents the correlation between the item and the factor. High number e.g. 0.8 means strong correlation and low number e.g. 0.4 shows weak correlation. The extracted factors explained 62% of the total variance of the 22 items. Factor 1 captures four items that are related to the complexity of adding soil, ash and emptying the vaults of the technology. Factor 2 captures five items that are related to the inconvenience of emptying vaults and handling recycled human excreta. Factor 3 captures 3 items that are related to shallow depth and incompatibility of the technology to large number of users at a property.

Table 7.6: Results from factor analysis (n=616)

Description	Factor loading
Factor 1: Complexity of operation	
The task of adding ash and soil all the time would stop me from adopting	0.85
The task of adding ash and soil is too involving.	0.88
The task of finding ash and soil is too involving.	0.84
The task of emptying is too involving	0.40
Factor 2: Inconvenience of emptying vaults and handling compost	
Access to compost would motivate me to adopt UDT	-0.69
The task of emptying compost from a toilet would stop me from adopting.	0.60
Lack of access to a garden would stop me from adopting.	0.77
Handling compost collected from ecological sanitation toilet is disgusting.	0.60
The task of emptying is too involving	0.56
Factor 3: Shallow depth and incompatibility with multiple number of users	
The shallow depth would stop me from adopting UDT	0.41
The number of people would stop me from adopting UDT	0.90
It is suitable with the number of people on my plot.	-0.91
Factor 4: Other benefits (lack of smell, cheap to empty and look modern	
I would be motivated to adopt because it does not smell.	0.57
I am would be motivated to adopt because it will make me look modern.	0.81
I would be motivated to adopt because it is cheaper to empty	0.76

Table 7.6 continued

Description	Factor loading
Factor 5: Permanency and safety of ecological sanitation	
I would be motivated to adopt because it is permanent	0.42
I would be motivated to adopt because it is safer for children.	0.86
I would be motivated to adopt because it will not collapse.	0.84
Factor 6: Influence of other people	
Other people that are important to me say that I should adopt UDT	0.77
Hygiene promoters say that I should adopt UDT	0.69
Masons/builders say that I should adopt a UDT	0.79
Factor 7: Affordability	
The installation cost would stop me from adopting	0.87
I can afford a UDT	-0.85

Data from 19 property owners excluded because of inconsistency and 16 property owners excluded from analysis as they had ecological sanitation

7.3.6 Barriers affecting the adoption of ecological sanitation

Table 7.7 presents the results of multivariable binary logistic regression with intention to adopt ecological sanitation (Urine diverting toilet) as the dependent variable and the extracted factors as explanatory variables. The table shows three key results: (i) there was a significant negative association between intention to adopt ecological sanitation and inconvenience of emptying vaults and handling recycled human excreta ($p = 0.04$), (ii) there was a significant negative association between intention to adopt ecological sanitation and incompatibility of the technology to users from multiple households ($p = 0.01$), (iii) there was also a significant negative association between intention to adopt ecological sanitation and affordability ($p < 0.001$). Binary logistic regression models based only on data only from survey respondents that had prior knowledge of ecological sanitation show similar results (appendix 5.1 and 5.2). Binary logistic regression models based on data from survey respondents that were planning to construct new sanitation facilities within one year after being interviewed show that affordability was a key barrier (appendix 5.3 and 5.4). These models were based on reduced sample size which may explain why only affordability was negatively associated with intention to adopt the technology.

Table 7.7: Barriers affecting the adoption of ecological sanitation (n=616)

Variable	Coef.	p-value	95% CI
Positive attributes			
Factor 5: Permanency and safety of ecological sanitation	-0.1	0.67	-0.4, 0.3
Factor 4: Other benefits (no smell, cheaper to empty, look modern)	0.0	0.80	-0.4, 0.3
Negative attributes			
Factor 1: Complexity of adding ash and soil after use	0.1	0.50	-0.2, 0.5
Factor 2: Inconvenience of emptying vaults and handling human excreta	-0.6	0.04	-1.1, - 0.02
Factor 3: Incompatibility with users from multiple households	-0.7	0.01	-1.2, - 0.2
Factor 6: Influence of other people	0.0	0.90	-0.3, 0.3
Factor 7: Affordability	-1.2	0.00	-1.5, - 0.9
_cons	-3.2	0.02	-5.9, -0.6

Note: Results from multivariable binary logistic regression with intention to adopt ecological sanitation as the dependent variable. Data from 19 property owners excluded because of inconsistency of data and 16 property owners were excluded from analysis as they had ecological sanitation

7.4 Discussion

Through mixed methods research and based on behaviour change theories, this chapter examined the drivers of demand for ecological sanitation. The results showed six drivers of demand for the technology and three barriers preventing property owners from adopting the technology. The drivers of demand for the technology and barriers preventing the adoption of the technology have important implications on the design, development and promotion of alternative sanitation technologies in low-income and high population density urban areas.

7.4.1 Drivers of demand for ecological sanitation

Previous research has shown that urban residents like the concept of ecological sanitation because it offers users sanitation facilities that are permanent, less smelly and users can access compost (cheap fertiliser) from recycled human excreta (Abraham, et al., 2011; Jackson, 2005). This chapter showed that nearly 100% of property owners liked the concept of ecological sanitation because it offers

technologies that are designed to be emptied and reused, less likely to collapse and safer for children to use compared to pit latrines. The results confirm that consumers purchase goods to yield one or more end-state goals and when they see a difference between an ideal state and their actual state (Bagozzi, 1999; Engel, 1978).

The results showed that the concept of recycling human excreta to access compost for food crop production – key objective of ecological sanitation - was not identified as a positive attribute or important attribute by 40% of the property owners. Access to compost appealed mainly to property owners that had access to gardens for food crop production. Access to compost from recycled human excreta is unlikely to be a key motivating factor as few residents (22%) in the city had access to gardens for food crop. Evidence from the qualitative research suggests that some property owners would adopt ecological sanitation and be throwing away the recycled human excreta as they have no use for it. Other researchers have also observed that households that do not have gardens for food crop production throw away the contents of their sanitation facilities (Morgan & Mekonnen, 2013). This observation confirms that when a behaviour is carried out, it can have positive and negative consequences (Ajzen, 2015; Rogers, 1995). The practice of throwing away compost from human excreta is a negative consequence which is not ideal as it has been found that users sometimes fail to add adequate dry matter into the vaults of ecological sanitation and that the drying of human excreta is not always optimum (Bhagwan et al., 2008). The promotion of ecological sanitation should therefore target property owners that have gardens for food crop production as they have use for the recycled human excreta. However, ownership of gardens for food crop production does not guarantee that users will use ecological sanitation appropriately as it has also been found that users sometimes empty the vaults of ecological sanitation much faster than recommended; when onset of agricultural season dictates the time users collect human excreta for food crop production (Jensen et al., 2009; Mehl, et al., 2011)

7.4.2 Barriers affecting the adoption of ecological sanitation

Although nearly 100% liked the concept of ecological sanitation, only 14% in Lilongwe City had intention to adopt ecological sanitation. Previous studies have shown that positive attributes or motivation alone is not enough for individuals to

change their behaviour. Individuals are able to change their behaviour when there are no barriers preventing the implementation of desired actions (Jenkins & Curtis, 2005). Results from this research suggest that affordability, incompatibility of the technology to users from multiple households and the inconvenience of emptying and handling human excreta are three key barriers affecting adoption of ecological sanitation in low-income and high population density urban areas.

Affordability is often identified as a barrier preventing property owners from adopting ecological sanitation (Abraham, et al., 2011). The results from this study confirmed that affordability is a key barrier preventing property owners from adopting the technology. Seventy one percent indicated that they could not afford ecological sanitation. Affordability was associated with income and gender of property owner. Male property owners compared to female property owners were 1.7 times more likely to indicate that they could afford to install ecological sanitation ($p < 0.05$) while property owners in the highest income category compared to those in the lowest income category were 2.4 times more likely to indicate that they could afford ecological sanitation ($p < 0.001$). As discussed by Cairncross (2004), it is important that organisations promoting alternative sanitation technologies provide a range of technologies at different prices to suit people with different incomes. However, introducing cheaper versions of ecological sanitation will increase the adoption of the technology to a limited extent as inconvenience of emptying and handling recycled human excreta and the incompatibility of the technology to multiple users from multiple households were also identified as key barriers.

Innovation research has shown that technologies that are perceived to be complex to use and not compatible with the needs of users are less likely to be adopted (Davis, 1989; Rogers, 1995). Inconvenience of emptying vaults and handling human excreta and incompatibility of the technology to users from multiple households were two key barriers. Other researchers have also observed that ecological sanitation is not easy to operate and maintain when it has to be shared among multiple households (Matsebe, 2011; Roma et al., 2013). This study underscores a central emerging theme in sanitation innovation research: proposed technologies must meet the needs of target population and be easy to operate and maintain, especially when shared among multiple households. This is consistent with the theory of diffusion of

innovation (Rogers, 1995; Venkatesh, 2000). The use of shared sanitation is widespread, with an estimated 784 million users of "shared public" and "shared private" latrines globally (WHO/UNICEF, 2014). In Lilongwe City, 66% of the sampled properties had shared sanitation. The design and promotion of alternative sanitation technologies must therefore be informed by this reality.

To make ecological sanitation compatible with multiple users, other researchers have recommended increasing the size of the vaults that collect faecal matter (Austin & Cloete, 2008; Morgan & Mekonnen, 2013). I argue against increasing the size of the vaults as this will make ecological sanitation even more expensive. In addition, increasing the size of the vaults does not remove the inconvenience of emptying and handling recycled human excreta. Furthermore, results from chapter five showed that where there is concern about space for replacing pit latrines, property owners construct replacement pit latrines on old pit latrine spots, bathroom spots or adopt. Thus many property owners empty pit latrines by digging them up several years after they fill up. This practice is easier and cheaper and it allows property owners and their tenants to maintain and operate sanitation facilities the way they have traditionally been operating and maintaining them unlike ecological sanitation which requires landlords and their tenants to completely change their behaviour with regard to the way they build, operate and maintain sanitation facilities.

Disgust with handling human excreta has been identified as one of the key barriers affecting the adoption of ecological sanitation (Nawab et al., 2006; Rosenquist, 2005). Many cultures have strongly-held beliefs and taboos regarding faeces which make ecological sanitation unworkable (Mariwah & Drangert, 2011). In this study, 20% perceived that handling recycled human excreta was disgusting. However, property owners that had prior knowledge about ecological sanitation were less likely to perceive that handling recycled human excreta was disgusting than those that did not have any prior knowledge. Other researchers have observed that after several years, users begin to understand the technology and overcome this barrier (Uddin et al., 2012). Therefore, disgust could be an initial reaction which changes as more people become knowledgeable and familiar with the technology.

7.5 Conclusion and recommendations

Property owners in low-income and high population density urban areas like the concept of ecological sanitation because it offers sanitation facilities that are permanent, less likely to collapse, safer for children to use and less smelly. However, the technology is unlikely to reach scale because it is perceived to be unaffordable, complex to operate and maintain particularly when shared among users from multiple households. In addition, many property owners have no use for recycled human excreta – the key objective of ecological sanitation. Change agents should therefore invest time and energy into understanding why current sanitation options are used, and what specifically users value about the existing options, since alternative sanitation technologies will be considered in light of existing options. Three strategies could be used to improve the adoption of alternative sanitation technologies such as ecological sanitation: (a) promote alternative sanitation technologies that are compatible with the needs and practices of the target audience, (b) offer property owners affordable sanitation options, (c) support urban residents particularly wealthier residents to avoid the inconvenience of emptying and handling recycled human excreta by offering emptying services.

Bibliography

Abraham, B., Kakumbi, G. M., Alam, M. M., & Von Muench, E. (2011). *Alternative solutions for challenging environments: A look at UNICEF-assisted ecosan projects worldwide.* *http://www.wedc.lboro.ac.uk/resources/conference/35/Abraham-B-1220.pdf*.

Ajzen, I. (2015). The theory of planned behaviour is alive and well, and not ready to retire: a commentary on Sniehotta, Presseau, and Araújo-Soares. *Health Psychology Review, 9*(2), 131-137. doi: 10.1080/17437199.2014.883474

Austin, L. M., & Cloete, T. E. (2008). Safety aspects of handling and using fecal material from urine-diversion toilets--a field investigation. *Water Environment Research, 80*(4), 308-315.

Bagozzi, R. P., Dholakia, U. (1999). Goal Setting and Goal Striving in Consumer Behaviour. *Marketing 1999*(63), 19.

Bhagwan, J. N., Still, D., Buckley, C., & Foxon, K. (2008). Challenges with up-scaling dry sanitation technologies. *Water Science and Technology, 58*(1), 21-27. doi: 10.2166/wst.2008.606

Cairncross, S. (2004). The case for marketing sanitation. http://wsp.org/UserFiles/file/af_marketing.pdf.

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use and User Acceptance of Information technology. *Management Information Systems Quarterly 13*(3), 319-340.

Engel, J. F., Blackwell, R.D., E Kollat, D.T. (1978). *Consumer behaviour.* Hinsdale, IL: Dryden Press.

Jackson, B. (2005). A Review of EcoSan Experience in Eastern and Southern Africa. http://www.susana.org/_resources/documents/default/2-295-jackson-2005-ecosan-experience-in-eastern-southern-africa-wspes.pdf.

Jenkins, M., & Scott, B. (2007). Behavioral indicators of household decision-making and demand for sanitation and potential gains from social marketing in Ghana. *Social Science & Medicine, 64*(12), 2427-2442.

Jenkins, M. W., & Curtis, V. (2005). Achieving the "good life": Why some people want latrines in rural Benin. *Social Science & Medicine, 61*(2005), 2446-2459.

Jensen, P. K. M., Phuc, P. D., Konradsen, F., Klank, L. T., & Dalsgaard, A. (2009). Survival of Ascaris eggs and hygienic quality of human excreta in Vietnamese composting latrines. *Environmental Health, 8*. doi: 5710.1186/1476-069x-8-57

Mariwah, S., & Drangert, J. (2011). Community perceptions of human excreta as fertilizer in peri-urban agriculture in Ghana. *Waste Management & Research, 29*(8), 815-822. doi: 10.1177/0734242x10390073

Matsebe, G. (2011). *A review of ecosan toilets in medium-density mixed housing developments.* *http://wedc.lboro.ac.uk/resources/conference/35/Matsebe-G-1243.pdf*.

Mehl, J., Kaiser, J., Hurtado, D., Gibson, D. A., Izurieta, R., & Mihelcic, J. R. (2011). Pathogen destruction and solids decomposition in composting latrines: study of fundamental mechanisms and user operation in rural Panama. *Journal of Water and Health, 9*(1), 187-199. doi: 10.2166/wh.2010.138

Morgan, P., & Mekonnen, T. (2013). Paving The Way to Scaling Up: Factors contributing to the adoption of ecos-san toilets. http://shareresearch.org/.../morgan_and_mekonnen_2013_paving_the_way_to_scaling_up_ecosan.pdf.

Nawab, B., Nyborg, I. L. P., Esser, K. B., & Jenssen, P. D. (2006). Cultural preferences in designing ecological sanitation systems in North West Frontier Province, Pakistan. *Journal of Environmental Psychology, 26*(3), 236-246. doi: http://dx.doi.org/10.1016/j.jenvp.2006.07.005

Norman, G. R., Streiner, D.L. (2000). *Biostatistics: The Bare Essentials.* 2nd Edition. BC Decker, Ontario.

Rogers, E. M. (1995). *Diffusion of Innovations*. Free Press, New York.

Roma, E., Philp, K., Buckley, C., Xulu, S., & Scott, D. (2013). User perceptions of urine diversion dehydration toilets: Experiences from a cross-sectional study in eThekwini Municipality. *Water Sa, 39*(2), 305-311. doi: 10.4314/wsa.v39i2.15

Rosenquist, L. E. D. (2005). A psychosocial analysis of the human-sanitation nexus. *Journal of Environmental Psychology, 25*(3), 335-346. doi: 10.1016/j.jenvp.2005.07.003

Uddin, S., Muhandiki, V. S., Fukuda, J., Nakamura, M., & Sakai, A. (2012). Assessment of social acceptance and scope of scaling up urine diversion dehydration toilets in Kenya. *Journal of Water Sanitation and Hygiene for Development, 2*(3), 182-189. doi: 10.2166/washdev.2012.078

Venkatesh, V. (2000). Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model. *Information Systems Research, 11*(4), 342-365. doi: doi:10.1287/isre.11.4.342.11872

WHO/UNICEF. (2014). Progress on Drinking Water and Sanitation - 2014 update. http://www.wssinfo.org.

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CHAPTER 8

CONCLUSION AND IMPLICATIONS ON ALTERNATIVE SANITATION TECHNOLOGIES

Using mixed methods research and based on the theory of planned behaviour, this thesis examined sanitation technology choices property owners in low-income and high population density urban areas make or are likely to make when faced with a range of sanitation options; local adaptation strategies property owners adopt where there is concern about space for replacing pit latrines, the perceptions and attitude of property owners towards ecological sanitation and their intention to adopt the technology. This chapter summarises the key results and discusses the implications of the results on the design of alternative sanitation technologies and their promotion in low-income and high population density urban areas.

8.1 Sanitation technology choices

Ecological sanitation has been introduced in several low-income and high population density urban areas to support urban residents to gain access to sustainable sanitation and to access cheap fertiliser from recycled human excreta (Abraham, et al., 2011). Although ecological sanitation offers users these benefits, the results suggest that property owners prefer installing pit latrines over the adoption of ecological sanitation. When property owners in the two cities were asked about their sanitation technology choices, 63% selected pit latrines, 19% opted to empty their current pit latrines and only 13% selected ecological sanitation. Pour flush and septic tank toilets were selected by fewer property owners (5%). Thus many (82%) property owners preferred pit latrines and pit emptying services over the adoption of ecological sanitation or pour flush/septic tank toilets.

Previous research identified household's occupation, education status, gender and knowledge about ecological sanitation as key determinants of demand for ecological sanitation (Tumwebaze & Niwagaba, 2011). Results from this thesis suggests that income status of property owners, the type of sanitation facility being used, number

of households at a property, access to gardens for food crop production, availability of piped water at a property and knowledge of ecological sanitation play a significant role in sanitation technology choices property owners make. These six factors are key socioeconomic and demographic indicators of demand for ecological sanitation.

The results showed that poorer property owners compared to wealthier property owners were 8.4 times more likely to select unimproved sanitation over ecological sanitation ($p < 0.001$) but the poorer property owners compared to wealthier property owners, were less likely to select pour flush/septic tank toilets over ecological sanitation ($p < 0.001$). Property owners that had piped water on their yard compared to those without piped water, were 1.6 times more likely to select pour flush/septic tank toilets over ecological sanitation ($p=0.05$). With regard to pit emptying service, the results showed that property owners that were using lined pit latrines compared to property owners that were using unlined pit latrines were 11.8 times more likely to prefer to empty their current pit latrines over adoption of ecological sanitation ($p<0.001$). The results also showed that a unit increase in the number of households (tenants) at a property increased the likelihood of selecting lined pit latrines over ecological sanitation (RRR=1.1, $p=0.02$). With regard to access to gardens for food crop production, the results showed that property owners that had gardens compared to those without gardens, were less likely to select unlined pit latrines over ecological sanitation (RRR=0.06, $p=0.02$) or unimproved sanitation[13] over ecological sanitation (RRR=0.06, $p=0.04$). The results further showed that property owners that had prior knowledge of ecological sanitation compared to those that did not have prior knowledge were less likely to select all other sanitation options over ecological sanitation; supporting the observation that innovation adoption decision process begins when an individual is exposed to an innovation's existence and gains an understanding of how it functions (Rogers, 1995).

The choices that property owners made suggest that the design and promotion of alternative sanitation technologies should be sensitive to the socioeconomic and demographic characteristics of property owners to be successful e.g. ecological sanitation should target property owners that have access to gardens for food crop

[13] Pit latrines without cement floor

production as they will have use for the compost from human excreta, pour flush toilets should target property owners that have easy access to water for flushing and lined pit latrines should target properties where there are multiple households. Ironically, organisations that were promoting sanitation in low-income urban areas at the time of data collection paid little attention to pour flush toilets and lined pit latrines. The results emphasise the importance developing sanitation interventions based on people's needs not on what experts think people want (Cairncross, 2004).

8.2 Effect of microfinance for sanitation on technology choices

It has been argued that the majority of residents in low-income and high density population urban areas may never be able to access formal mortgage finance to improve their shelter and sanitation (Merrill, 2012). Improving access to microfinance for sanitation improvement - the provision of small loans to the very poor - is therefore seen an important strategy for improving access to improved and sustainable sanitation (Davies & Tinsley, 2013; Trémolet, 2012; WSP, 2004).

When survey respondents were offered a microfinance option, the proportion of respondents that selected ecological sanitation increased from 13% to 32%, the proportion of property owners that selected unimproved sanitation reduced from 14% to 8% and the proportion of property owners that selected pit emptying service decreased from 19% to 12%. Most property owners that selected unimproved sanitation before the microfinance option was offered switched to pit latrines with cement floor and Fossa alterna toilets (cheaper type of ecological sanitation) when microfinance option was offered. At the time of data collection, microfinance for sanitation was being offered only for Urine diverting toilets (expensive type of ecological sanitation). The results emphasise the importance of a flexible microfinance for sanitation programme that allows property owners to select technologies of their choice rather than targeting microfinance only on sanitation technologies that are perceived by change agents as expensive or important.

The results suggest that sanitation interventions that focus on the promotion of alternative sanitation technologies without improving access to microfinance for sanitation are less likely to be successful. The results also suggest that improving

access to microfinance for sanitation would increase demand for ecological sanitation and alternative sanitation technologies in general. It should however be noted that efforts to improve access to microfinance for sanitation may not benefit all urban residents. After offering property owners an option for microfinance for sanitation, some property owners (8%) still selected unimproved sanitation. This observation supports the argument raised by Toubkiss (2010), who explained that microfinance is often inaccessible to poorer households. Very poor urban property owners will need other types of interventions to access sustainable sanitation e.g. subsidies, vouchers (WSP, 2004).

8.3 Attitude of property owners towards ecological sanitation

The analysis of sanitation technology choices described in the previous section used socioeconomic and demographic characteristics of property owners as indicators of demand for ecological sanitation. However, without understanding the perceptions and attitude of property owners towards ecological sanitation, it is difficult to explain why property owners made the choices they made, for example it is difficult to explain why wealthier property owners compared to poorer property owners were less likely to select ecological sanitation over pour flush/septic tank toilets. Commenting on the weaknesses of using socioeconomic characteristics as indicators of demand for sanitation, Jenkins and Scott (2007) explained that socioeconomic indicators lack explanatory power and they offer little information for developing effective sanitation marketing strategies. Research by Santos (2011) suggests that people's attitudes towards alternative sanitation options affect individuals' choices and their decision making process towards different sanitation technology options.

8.3.1 Positive attributes of ecological sanitation

Research has shown that households adopt new sanitation behaviour when there is at least one active drive for change (Jenkins & Curtis, 2005). When property owners were asked about their perceptions towards ecological sanitation, nearly 100% liked the concept of ecological sanitation because it offers users sanitation facilities that are designed to be emptied and reused (permanent facility), less likely to collapse and safer for children to use. Ninety three percent liked the concept of ecological

sanitation because it offers facilities that are less smelly and 80% liked the concept of ecological sanitation because it offers facilities that are cheaper to empty. With regard to access to compost from human excreta (cheap fertiliser), the results showed that 40% were not attracted to the concept of recycling human excreta to access compost for food crop production – key objective of ecological sanitation. Proponents of ecological sanitation emphasise that access to cheap fertiliser from recycled human excreta can improve household food production and income (Jackson, 2005). The results suggest that this benefit does not appeal to many property owners in low-income urban areas. The results suggest that property owners value owning sanitation facilities that are permanent, less likely to collapse, safer for children to use, less smelly and cheaper to empty more than they value access to cheap fertiliser for food crop production. The design, development and promotion of alternative sanitation technologies should focus on offering property owners and their tenants sanitation facilities that are permanent, less likely to collapse, easier to empty than access to cheap fertiliser from recycled human excreta.

8.3.2 Negative attributes of ecological sanitation

While alternative sanitation options may offer users several benefits over existing sanitation options, they are less likely to be adopted if there are any barriers preventing households from changing their behaviour (Jenkins, 2004). The results showed that 71% could not afford ecological sanitation, 33% found the technology to be incompatible with multiple users, 20% indicated that handling compost from recycled human excreta was disgusting, 18% found the task of emptying the technology as too involving while 12% indicated that the task of adding ash and soil into the vaults of the technology after defecating was involving.

Results from multivariable binary logistic regression showed that intention to adopt ecological sanitation was negatively associated with the installation cost of the technology (coef = -1.2, $p < 0.001$), incompatibility of the technology to users from multiple households (coef = -0.7, $p = 0.01$) and the inconvenience of emptying and handling human excreta (coef = -0.6, $p = 0.04$). Other researchers have identified the installation cost and complexity of maintenance when the technology is shared among multiple households as key challenges associated with ecological sanitation

(Abraham, et al., 2011; Matsebe, 2011; Roma, et al., 2013). The results confirm that technologies that are perceived to be incompatible with the needs of the target audience and complex or too involving to use are less likely to be adopted than technologies that meet the needs of the target audience and are perceived to be easy to use (Davis, 1989; Rogers, 1995).

8.3.3 The benefits of examining people's attitude towards alternative technologies

The attitudes of property owners towards the technology were strongly associated with income status, presence of tenants at a property and knowledge of ecological sanitation. The results showed that wealthier property owners compared to poorer property owners were 1.8 times more likely to perceive that the task of emptying the technology was too involving ($p=<0.05$). The results also showed that wealthier property owners compared to poorer property owners were 2.4 times more likely to perceive that the task of adding ash and soil into the vaults that collect faecal matter was too involving ($p=0.01$) and property owners that had tenants compared to those without tenants were 5.3 times more likely to perceive that the technology was not compatible with multiple users ($p<0.001$). The results further showed that property owners that had access to gardens compared to those without gardens were 3.3 times more likely to indicate that access to compost from human excreta was a positive attribute and property owners that had prior knowledge of ecological sanitation compared to those without prior knowledge were less likely to perceive that the task of handling human excreta was disgusting ($OR =0.5$, $p = 0.05$).

By examining people's attitude and their socioeconomic, demographic characteristics, we begin to understand why the property owners made the choices they made. It is often argued that the adoption of ecological sanitation is too slow because it is expensive (Abraham, et al., 2011). The results suggest that the adoption of ecological sanitation is not only slow because it is expensive, but also because the technology does not meet the needs of wealthier property owners or property owners that have multiple households (tenants) or property owners that do not have access to gardens for food crop production. Wealthier property owners were more likely to find the technology to be too involving to use and too involving to empty and this explains why there were more likely to select pour flush/septic tank toilets over

ecological sanitation. On the other hand, poorer property owners were more likely to find the technology to be too expensive and this explains why they were more likely to select unimproved sanitation over ecological sanitation. Property owners that had multiple households were more likely to find the technology to be incompatible with multiple users and this explains why they were more likely to select lined pit latrines.

These observations suggest that ecological sanitation - in its current design and promotion (small vaults, limited microfinance, no emptying services) - is not addressing the needs of both poorer and wealthier property owners and neither is it addressing the needs of property owners that have multiple households (tenants). To reach scale, alternative sanitation technologies should be affordable, easy to use and operate, compatible with users from multiple households and compatible with the needs of the target audience. In addition, when promoting alternative sanitation technologies that require users to handle human excreta, promoters should consider offering an option for emptying services.

8.4 Causes of concern about space for replacing pit latrines

Pit latrines eventually fill up and must be replaced or emptied. One of the key challenges facing residents in low-income and high population density urban areas is availability of space for replacing pit latrines when they fill up or collapse (Hawkins, Blackett, & Heymans, 2013; Isunju, et al., 2011). When asked about availability of space, 75% indicated that they were not concerned about space for replacing pit latrines while 25% were concerned about space for replacing pit latrines. The results showed that concern about space for replacing pit latrines was associated with type of pit latrine in use, number of households at a property, availability of vacant space and concern about high groundwater table.

Property owners that were using unimproved sanitation compared to those that were using lined pit latrines were 1.9 times more likely to be concerned about space for replacing pit latrines ($p=0.01$) while property owners that were using pit latrines with slab/cement floor but no lined pits compared to those that were using lined pit latrines were 2.5 times more likely to be concerned about space for replacing pit latrines (<0.001) , property owners that did not have vacant space within their plots

compared to those that had vacant space were 3.5 times more likely to be concerned about space for replacing pit latrines ($p<0.001$) and a unit increase in the number of households at a property increased the odds of being concerned about space for replacing pit latrines (OR=1.1, p=0.004). Property owners that had lined pit latrines were less likely to be concerned about space for replacing pit latrines because lined pit latrines are less likely to collapse and can be emptied compared to unlined pit latrines (Jenkins et al., 2015). These results suggest that efforts to promote access to sustainable sanitation should not focus only on the promotion of alternative sanitation technologies but also on supporting property owners to gain access to lined pit latrines and regulating the number of houses property owners build to ensure that they are reserving enough space for replacing pit latrines.

8.5 The limitations of technological adaptation strategies

Research has shown that when there is a threat to wellbeing, individuals do adapt to their changing environmental conditions using their knowledge, experience and available resources (Smit & Wandel, 2006; Smithers & Smit, 1997). Where there is concern about space for replacing pit latrines, property owners prefer to change the way they build, operate and maintain pit latrines to adoption of ecological sanitation.

Results from multinomial logistic regression examining sanitation technology choices where there is concern about space for replacing pit latrines showed that an increase in the level of concern about space for replacing pit latrines increased the likelihood of emptying current pit latrine over construction of new pit latrines with cement floor (RRR = 1.2, p=0.03). The results also showed that an increase in the level of concern about space for replacing pit latrines increased the likelihood of selecting Fossa alterna toilets (cheaper type of ecological sanitation) over construction of unlined pit latrines (RRR=1.2, p=0.04). However, there was no association between an increase in the level of concern about space for replacing pit latrines and Urine diverting toilets (expensive type of ecological sanitation). At the time of the study, one could empty a pit latrine with MK20, 000 while a urine diverting toilet was costing MK70, 000 to MK90, 000 and fossa alterna was MK30, 000 to MK50, 000. A pit latrine slab was only MK5, 000 so one could build a new pit latrine with less than MK20, 000.

To adopt ecological sanitation, property owners and their tenants are required to completely change (transform) the way they build, operate and maintain sanitation facilities. Transformational adaptation is found to be very difficult than behavioural adjustment because of the effort and resources required to implement transformational actions (Kates, et al., 2012). Unless alternative sanitation technologies are affordable, easy to use and compatible with users from multiple households, property owners in low-income and high population density urban areas are less likely to address the limitations of pit latrines by adopting alternative sanitation. Instead, property owners will seek to improve the build quality of pit latrines and change the way they operate and maintain them.

One of the key adaptation strategies property owners implement when there is concern about space is to construct replacement pit latrines on old pit latrine spots. By constructing replacement pit latrines on old pit latrine spots, property owners are already emptying their pit latrines without adopting alternative sanitation technologies or requiring sophisticated pit emptying equipment. This suggest that pit emptying in low-income urban areas does not mean emptying faecal sludge as soon as a pit latrine fills up, but also several years after pit latrines fill up. The average pit latrine life in Malawi is 3.9 years (MIWD, 2008). Thus property owners that construct replacement pit latrines on old pit latrine spots, empty their pit latrines less frequently compared to ecological sanitation which must be emptied frequently. A single vault of ecological sanitation facility is designed to be emptied 6 to 12 months after closing it (Morgan & Mekonnen, 2013). However, in some cases, vaults fill up much faster than expected forcing users to empty them before they wait for more than 6 months (Bhagwan et al., 2008; Morgan & Mekonnen, 2013).

Other researchers have suggested that the vaults of ecological sanitation should be enlarged so that the technology should be used by more households and fill up less frequently (Austin & Cloete, 2008; Morgan & Mekonnen, 2013). I argue against increasing the vaults of ecological sanitation as it will make the technology even more unaffordable. Furthermore, this strategy does not remove the challenges of adding adequate dry matter, the complexity of using the technology when it is shared among multiple households and the inconvenience of emptying vaults and handling

human excreta. Instead, change agents should focus on supporting property owners to improve the build quality of pit latrines (e.g. make them less likely to collapse and easier to empty) and support property owners to safely dispose soil from old pit latrines that are dug up several years after they fill up. The design and promotion of hygienic pit emptying services should consider that property owners also empty pit latrines several years after they fill up not only as soon as they fill up. City authorities should explore how the practice of constructing replacement pit latrines on old pit latrine spots or bathroom spots can be enhanced and be made safe to protect human health and natural resources.

8.5.1 The importance of enforcing building regulations

Efforts to safely manage faecal sludge focus on alternative sanitation technologies, improvements in pit emptying technology and faecal sludge treatment and disposal. These efforts are necessary but they do not address the root causes of the problem of space for replacing pit latrines. A sustainable strategy must also address the root causes of undesired change (Fazey, et al., 2010; Kelly & Adger, 2000). Concern about space for replacing pit latrines arise when urban residents replace pit latrines frequently and when they build multiple houses at the expense of space for replacing pit latrine. Ha argued that property owners build multiple houses at the expense of space for sanitation because of lack of building regulations.

I t has been argued that to gain access to safely managed sanitation, users must be connected to the sewer network or they must be able to store excreta on-site until it is safer to empty and handle human excreta (WHO/UNICEF, 2014). For a household to store excreta onsite until it is safe to handle, they must have vacant space for replacing pit latrines. City authorities should therefore consider regulating the number of houses property owners build to ensure that they are reserving enough space for sanitation. The results showed that 75% were not concerned about space for replacing pit latrines. Thus city authorities still have an opportunity to regulate the way property owners build houses to ensure that they are reserving adequate space for replacing pit latrines. Regulating the way property owners build houses is important because many property owners are unlikely to be connected to the sewer

network and also because many city authorities do not have the financial resources and structures to safely collect and treat faecal sludge (Peal et al., 2014).

8.6 Pit latrine emptying services or alternative technology?

In rapidly urbanising settlements, hygienic pit emptying services and alternative sanitation technologies offer residents two competing strategies for gaining access to sustainable sanitation (Abraham, et al., 2011; Thye et al., 2011). When property owners were asked about their choices in Blantyre City, 28% preferred to empty their current pit latrines over construction of new pit latrines or adoption of ecological sanitation. The most frequently identified reasons for selecting pit emptying services over construction of new pit latrines or adoption of ecological sanitation were that pit emptying was cheaper than construction of new sanitation facilities (91%) and that the quality of the pit latrine was too good to pull it down (66%). Lack of space was identified as a reason for emptying by fewer property owners (30%).

As already discussed under the section on adaptation strategies, property owners improve the build quality of pit latrines to extend their lifespan. This suggests that as cities urbanise and space for replacing pit latrines becomes limited, property owners will seek to improve the build quality of their pit latrines and demand pit emptying services. The results suggest that the quality of pit latrines is a key driver of demand for pit emptying services not directly rapid urbanisation as previously suggested (Thye et al., 2011). The results suggest that property owners do not look at the savings they will make in future if they adopt an alternative sanitation technology such as ecological sanitation. Their decision is guided by how much they will spend if they empty their current pit latrine or adopt an alternative sanitation technology. As long as emptying current pit latrine is cheaper than adopting an alternative sanitation technology; property owners will prefer to empty their current pit latrines to adoption of alternative technologies.

Unless alternative sanitation technologies are affordable, it will be difficult to significantly increase the market share of alternative sanitation technologies when property owners could spend less money by emptying their pit latrines. Access to microfinance for sanitation could help increase the market share of alternative

sanitation technologies and reduce demand for pit emptying services. The proportion of property owners that preferred to empty their pit latrines reduced significantly (from 19% to 12%) when microfinance for sanitation was offered. About 50% of the property owners that had intention to empty their pit latrines before the microfinance option was offered, switched to ecological sanitation after they accepted microfinance for sanitation.

8.6.1 Price elasticity of demand for pit emptying services

When pit emptying service fees increased from MK10, 000 to MK 20, 000; the proportion of property owners that selected pit emptying service reduced by 50%. This supports the observation that prices play a significant role in choices that people make (Mcpake, 2013). However, property owners that were using lined pit latrines were less responsive to the price increase compared to property owners that were using unlined pit latrines or unimproved sanitation (pit latrines without cement floor). Among those that were using lined pit latrines, the proportion of property owners that selected pit emptying service reduced by 20% when pit emptying service fees increased compared to a reduction of 77% among property owners that were using unlined pit latrines and a reduction of 92% among property owners that were using unimproved sanitation. These observations support the finding that it is the quality of pit latrines that drives pit emptying services not simply rapid urbanisation.

8.6.2 Effect of an increase in pit emptying service fees on ecological sanitation

Another important observation was that the proportion of ecological sanitation increased from 6% to 11% when pit emptying service fees increased. This suggests that an increase in pit emptying service fees will influence property owners to seek alternative sanitation technologies that are easier and cheaper to empty. The results suggest that as cities urbanise and the cost of emptying pit latrines increase, demand for alternative sanitation technologies will increase. City authorities and sanitation technology experts should therefore ensure that property owners have access to alternative sanitation technologies that are affordable, easy to use and maintain and compatible with users from multiple households.

8.7 Conclusion and recommendations

Property owners in low-income urban areas like the concept of ecological sanitation because it offers sanitation facilities that are designed to be emptied and reused, less likely to collapse, safer for children to use, cheaper to empty and less smelly. However, ecological sanitation facilities are too expensive, the task of emptying and handling human excreta is inconvenient and the facilities are not suitable for sharing - key requirement in high population density urban areas - because they have small vaults and they become too involving to use when shared among multiple households. Furthermore, many property owners do not perceive that access to compost from recycled human excreta is an important attribute.

Where there is concern about space for replacing pit latrines, property owners prefer to adapt by changing the way they build, operate and maintain pit latrines to adoption of ecological sanitation. Adaptation strategies property owners implement are cheaper and compatible with way property owners and their tenants have traditionally been building, operating and maintaining sanitation facilities. As urban population continues to grow and space for replacing pit latrines becomes limited, property owners will more likely seek to improve the build quality of pit latrines and demand pit emptying services. To support property owners and their tenants gain access to sustainable sanitation through the adoption of alternative sanitation technologies, sanitation technology experts and change agents should ensure that alternative sanitation technologies are affordable, easy to use and maintain, safer for children to use and suitable for sharing. However, without improving access to microfinance for sanitation, the promotion of alternative sanitation technologies will not significantly increase access to sustainable sanitation.

8.5 Research limitations

1. The research was based on stated choices as it was impossible to use actual choices since organisations promoting sanitation in low-income urban areas do not keep sales data or capture socioeconomic and demographic data of property owners adopting alternative sanitation technologies. A key challenge is that stated choices are not usually the same as actual choices. However, the results provide useful information for developing urban sanitation policies and guiding the design and development of alternative sanitation technologies.

2. The research was based on the theory of planned behaviour. The results assume that property owners were rational in their decision making process and that they reviewed all available information in unbiased fashion before they selected sanitation technologies of their choice.

3. The pit emptying service option was based on a gulper – a manually operated pit emptying equipment. The challenge with this equipment is that it does not empty thick faecal sludge and cannot empty pit latrines that are over 2 meters deep. Basing pit emptying service on a gulper may have affected the choices of property owners that had knowledge about the gulper. However, emptying using a gulper is a pilot project and very few property owners had experience of using a gulper to empty their pit latrines.

8.8 Implications on urban sanitation policies and strategies

1) The development and promotion of ecological sanitation should target property owners without tenants and urban residents that have gardens for food crop production or residents that live in areas with shallow bedrock or high groundwater table where pit latrines are difficult to implement. In its current design, ecological sanitation should not be for multiple households.

2) The promotion of alternative sanitation technologies should not focus only on ecological sanitation but also on pour flush toilets. Pour flush toilets should target property owners that have piped water within their yard.

3) Sanitation technology experts and sanitation manages should consider offering urban residents cheaper and expensive options of alternative sanitation technologies to give poorer residents an opportunity to access alternative sanitation technologies.

4) Sanitation technology experts should not focus only on the development and promotion of alternative sanitation technologies but also on improving the build quality of pit latrines to make them less likely to collapse, easier and safer to empty, less smelly and safer for children to use.

5) Sanitation programs that focus only on the promotion of alternative sanitation technologies without improving access to microfinance for sanitation are less likely to be successful. Microfinance for sanitation should not target only technologies that are perceived to be expensive by experts but should be open to all available improved sanitation technologies.

6) City authorities should consider regulating the number and size of houses property owners build to ensure that property owners are reserving enough space for replacing pit latrines. Availability of space for replacing pit latrines will allow urban residents to store human on-site until it will be safer to empty.

7) City authorities should consider allocating adequate resources for the development and promotion of hygienic pit emptying services. Hygienic pit emptying services should include collection, treatment and disposal of human excreta from alternative sanitation technologies such as ecological sanitation, from pit latrines as soon as they fill up as well as when they are dug up several years after they fill up.

8.9 Future research

1. Where there is concern about space for replacing pit latrines, property owners build replacement pit latrines on old pit latrine spots. Thus pit latrines are also

emptied several years after they fill up. It is important to examine the safety and disposal of soil from pit latrines that are dug up several years after they fill up.

2. Building replacement pit latrines on old pit latrine spots, emptying pit latrines as soon as they fill up or adoption of alternative sanitation technologies are three competing strategies urban residents could adopt to maintain access to sanitation. These strategies would require different pit emptying services and technologies. To guide pit emptying investment plans, it is important to examine whether property owners would prefer to adopt alternative sanitation technologies, empty pit latrines as soon as they fill up or dig them up several years after they fill up.

3. Bathrooms and pit latrines usually occupy different spaces/spots. Where there is concern about space, urban residents swap the locations of these two facilities. Future research should examine how these two facilities should be designed and built to support urban residents to maximise use of available space.

4. Property owners liked the concept of ecological sanitation because it is less smelly. But ecological sanitation is less smelly because users add ash and soil into the vaults that collect faecal matter. Future research should examine the attitude of property owners towards adding ash and soil into pit latrines to reduce smell. This practice could increase the filling rate of pit latrines but it has several advantages: users start the process of treating human excreta on-site (like ecological sanitation), users have access to sanitation facilities that will take several years before filling up (unlike ecological sanitation facilities that that take 6 to 12 months to fill up), users will not need sophisticated equipment to empty the facilities as emptying will be like digging a new pit hence simple tools e.g. hoes, shovels and buckets/bags for lifting soil could be used.

5. A key barrier to the adoption of ecological sanitation was the inconvenience of emptying and handling human excreta. By offering emptying services for ecological sanitation, users could avoid the inconvenience of emptying and handling human excreta. Future research should examine whether offering emptying service for ecological sanitation or other alternative technologies would increase their adoption.

6. Future research should also examine whether offering residents microfinance for sanitation designed in such a way that monthly payments cover emptying service fees and the investment cost of the sanitation facility would increase the adoption of alternative sanitation technologies such as ecological sanitation.

8.8 Implications for urban sanitation research

1) Urban sanitation researchers are more likely to gain a deeper understanding of the choices property owners make when faced with a range of sanitation options through the use of qualitative and quantitative research methods (mixed methods) sequentially rather than using quantitative or qualitative methods alone.

2) Stated preference survey offers researchers a deeper understanding of the choices that property owners in low-income urban areas make or are likely to make. However, to acquire a fuller picture of peoples' sanitation technology choices, it is important to assess technology choices under two conditions: with and without access to microfinance for sanitation.

3) Urban sanitation researchers should aim at understanding the attitude of property owners towards alternative sanitation technologies as well as the socioeconomic, demographic characteristics of property owners likely to accept or reject alternative sanitation technologies. Without understanding people's attitude towards alternative sanitation technologies, it will be difficult to explain the reasons behind the sanitation technology choices property owners make.

4) The promotion of alternative sanitation technologies such as ecological sanitation and pit emptying services offer urban residents two key options for addressing the limitations of pit latrines particularly lack or limited space for replacing pit latrines. Urban sanitation research for planning purposes should aim at establishing the proportion of urban residents likely to adopt ecological sanitation or other alternative sanitation technologies and those likely to continue with pit latrines and demand pit emptying services.

5) To fully understand the sanitation choices of urban residents and guide the development of urban sanitation policies and investment plans, it is important to include pit emptying services and alternative sanitation technologies in the choice set offered to property owners. The proposed survey questionnaire (appendix 8), developed from the strengths and weaknesses of this thesis addresses how stated preference surveys can be carried out to provide information for planning urban sanitation services. The survey questionnaire has been designed to capture: (1) attitude of property owners towards their current sanitation facilities and alternative sanitation technologies, (2) the proportion of property owners seeking pit emptying services and those likely to adopt alternative sanitation technologies, (3) strategies that urban residents are planning to implement to address the limitations of pit latrines e.g. limited space or shallow bedrock, (4) the effect of microfinance for sanitation on sanitation technology choices.

Bibliography

Abraham, B., Kakumbi, G. M., Alam, M. M., & Von Muench, E. (2011). *Alternative solutions for challenging environments: A look at UNICEF-assisted ecosan projects worldwide.* *http://www.wedc.lboro.ac.uk/resources/conference/35/Abraham-B-1220.pdf*.

Austin, L. M., & Cloete, T. E. (2008). Safety aspects of handling and using fecal material from urine-diversion toilets--a field investigation. *Water Environment Research, 80*(4), 308-315.

Bhagwan, J. N., Still, D., Buckley, C., & Foxon, K. (2008). Challenges with up-scaling dry sanitation technologies. *Water Science and Technology, 58*(1), 21-27. doi: 10.2166/wst.2008.606

Cairncross, S. (2004). The case for marketing sanitation. http://wsp.org/UserFiles/file/af_marketing.pdf.

Davies, A., & Tinsley, J. (2013). *Water Credit: A case study of microfinance for household water and sanitation improvements in India and Kenya.* Paper presented at the 36th WEDC International Conference: Delivering Water, Sanitation and Hygiene Services in an Uncertain Environment.

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use and User Acceptance of Information technology. *Management Information Systems Quarterly 13*(3), 319-340.

Fazey, I., Gamarra, J. G. P., Fischer, J., Reed, M. S., Stringer, L. C., & Christie, M. (2010). Adaptation strategies for reducing vulnerability to future environmental change. *Frontiers in Ecology and the Environment, 8*(8), 414-422.

Hawkins, P., Blackett, I., & Heymans, C. (2013). Poor-Inclusive urban Sanitation: An Overview Washington, DC: Water and Sanitation Program, The World Bank. http://www.wsp.org/.../WSP-Poor-Inclusive-Urban-Sanitation-Overview.pdf.

Isunju, J. B., Schwartz, K., Schouten, M. A., Johnson, W. P., & van Dijk, M. P. (2011). Socio-economic aspects of improved sanitation in slums: A review. *Public Health, 125*(6), 368-376.

Jackson, B. (2005). A Review of EcoSan Experience in Eastern and Southern Africa. http://www.susana.org/_resources/documents/default/2-295-jackson-2005-ecosan-experience-in-eastern-southern-africa-wspes.pdf.

Jenkins, M., & Scott, B. (2007). Behavioral indicators of household decision-making and demand for sanitation and potential gains from social marketing in Ghana. *Social Science & Medicine, 64*(12), 2427-2442.

Jenkins, M. W. (2004). Who Buys Latrines, Where and Why? http://wsp.org/sites/wsp.org/files/publications/af_latrines.pdf.

Jenkins, M. W., Cumming, O., & Cairncross, S. (2015). Pit Latrine Emptying Behavior and Demand for sanitation Services in Dar Es Salaam, Tanzania. *International Journal of Environmental research and Public Health, 2015*(12), 2588-2611.

Jenkins, M. W., & Curtis, V. (2005). Achieving the "good life": Why some people want latrines in rural Benin. *Social Science & Medicine, 61*(2005), 2446-2459.

Kates, R. W., Travis, W. R., & Wilbanks, T. J. (2012). Transformational adaptation when incremental adaptations to climate change are insufficient. *Proceedings of the National Academy of Sciences, 109*(19), 7156-7161. doi: 10.1073/pnas.1115521109

Kelly, P. M., & Adger, W. N. (2000). Theory and Practice in Assessing Vulnerability to Climate Change and Facilitating Adaptation. *Climatic Change, 47*(4), 325-352. doi: 10.1023/A:1005627828199

Matsebe, G. (2011). *A review of ecosan toilets in medium-density mixed housing developments. http://wedc.lboro.ac.uk/resources/conference/35/Matsebe-G-1243.pdf*.

Mcpake, B., Normand, C., Smith, S. (2013). *Health Economics: An international Economics.* Third edition. New York: Routledge.

Merrill, S. R. (2012). Microfinance for Housing. In S. J. Smith (Ed.), *International Encyclopedia of Housing and Home* (pp. 274-281). San Diego: Elsevier.

MIWD. (2008). The National Sanitation Policy, Malawi Government. http://www.ircwash.org/sites/default/files/842-MW06-19182.pdf.

Morgan, P., & Mekonnen, T. (2013). Paving The Way to Scaling Up: Factors contributing to the adoption of ecos-san toilets. http://shareresearch.org/.../morgan_and_mekonnen_2013_paving_the_way_to_scaling_up_ecosan.pdf.

Peal, A., Evans, B., Blackett, I., Hawkins, P., & Heymans, C. (2014). Faecal sludge management: a comparative analysis of 12 cities. *Journal of Water, Sanitation and Hygiene for Development., 4*(4).

Rogers, E. M. (1995). *Diffusion of Innovations*. 5th edition. New york: Free Press.

Roma, E., Philp, K., Buckley, C., Xulu, S., & Scott, D. (2013). User perceptions of urine diversion dehydration toilets: Experiences from a cross-sectional study in eThekwini Municipality. *Water Sa, 39*(2), 305-311. doi: 10.4314/wsa.v39i2.15

Santos, A. C., Roberts, Jennifer A., Barreto, Mauricio L., Cairncross, Sandy. (2011). Demand for sanitation in Salvador, Brazil: A hybrid choice approach. *Social Science & Medicine, 72*(8), 1325-1332. doi: 10.1016/j.socscimed.2011.02.018

Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change-Human and Policy Dimensions, 16*(3), 282-292. doi: 10.1016/j.gloenvcha.2006.03.008

Smithers, J., & Smit, B. (1997). Human adaptation to climatic variability and change. *Global Environmental Change, 7*(2), 129-146.

Thye, Y. P., Templeton, M. R., & Mansoor, A. (2011). A Critical Review of Technologies for Pit Latrine Emptying in Developing Countries. *Critical Reviews in Environmental Science and Technology, 41*(20), 1793-1819. doi: 10.1080/10643389.2010.481593

Toubkiss, J. (2010). Meeting the sanitation challenge in sub-saharan cities: Lessons learnt from a financial perspective *Social Perspectives on the Sanitation Challenge* (pp. 163-176).

Trémolet, S. (2012). Small-scale finance for water and sanitation. http://www.gwp.org/Global/About%20GWP/Publications/EUWI/EUWI__SHARE_final.pdf.

Tumwebaze, I. K., & Niwagaba, C. B. (2011). *Ecological sanitation uptake, knowledge, beliefs and practices in Kabale Municipality, Kabale District. Retrieved from http://wedc.lboro.ac.uk/resources/conference/35/Tumwebaze-I-K-1266.pdf*.

WHO/UNICEF. (2014). Progress on Drinking Water and Sanitation - 2014 update. http://www.wssinfo.org.

WSP. (2004). Making toilets more affordable for the poor through microfinance: Lessons learned from introducing microfinance loans for sanitation in rural Cambodia. http://wsp.org/sites/wsp.org/files/publications/WSP-Learning-Note-Toilets-Through-Microfinance-Cambodia.pdf. *WSP - Learning Note*.

Appendix 1: Product information provided

Technology	Advantages presented to survey respondents	Disadvantages presented to survey respondents	Estimated cost offered to survey respondents in Kwacha (MK)
Urine diverting toilet (UDT)	• Access to compost • Permanent (build once never build again) • Will not collapse. • Safer for children. • Does not smell. • Make you look modern. • Cheaper to empty.	• Shallow depth. • Empty regularly. • Collecting ash and soil • Adding ash and soil after defecating. • Handling compost from the toilet.	70,000 to 90,000
Fossa alterna	• Access compost • Permanent. • Will not collapse. • Safer for children. • Does not smell. • Make you look modern. • Cheaper to empty.	• Shallow depth. • Empty regularly. • Collecting ash and soil • Adding ash and soil after defecating. • Handling compost from the toilet.	30,000 to 50,000
Pour flush toilet	• Permanent. • Less likely to collapse. • Does not smell. • Make you look modern.	• Need money to empty it when it fills up. • Must have access to water for flushing.	90,000 to 110,000
Lined pit latrine: Research assistants introduced a lined pit latrine using a photograph. The advantages and disadvantages of lined pit latrines were not discussed as was the case with the alternative sanitation technologies. It was assumed that survey respondents would be familiar with the concept of lining pits.			70,000 to 90,000
A pit latrine slab/cement floor: Survey respondents were offered an estimated cost of a slab/cement floor. The advantages and disadvantages of a slab/cement floor were not discussed as it was assumed that survey respondents would be familiar with the concept of a pit latrine with a slab/cement floor considering that pit latrines with slab/cement are common in low-income urban areas.			5,000
Pit emptying service using a gulper: Respondents were shown pictures of men emptying a pit latrine using a Gulper. Respondents were informed that people emptying with a gulper are able to reach houses even where there are no roads for vacuum tankers. Survey respondents were not informed about how deep their facilities would be emptied. The service was based on the assumption that the entire pit would be emptied and that the pit emptiers would empty the faecal sludge at a wastewater treatment plant.			20,000
Additional information: In addition to these options, survey respondents were informed that they could install any other sanitation technology of their choice including pit latrines with mud floors (unimproved sanitation) or septic tank toilets. It was difficult to estimate the cost of a mud floor pit latrine as property owners use a range of materials and sometimes construct on their own.			

1 GBP = 550 Malawi Kwacha (MK) at the time of the survey

Appendix 2: Photographs used to introduce technologies.

Urine diverting toilet (UDT)

Front view

Chamber doors for emptying and pipe for diverting urine into a soak pit

Interior view

Fossa alterna toilet

interior view

Pour flush toilet

Pour flush, bucket for keeping water for flushing

Men emptying a pit latrine using a gulper and drums

Lined pit latrine

Appendix 3: Microfinance information provided to respondents

Now imagine that there is an opportunity for a loan for you to build a toilet of your choice. If the amount offered to be taken as a loan ranged from MK10, 000 to MK100, 000. The loan is to be paid back within one year or two years at an interest of 2% which is charged on your loan balance every month. If you pay back the loan within a year, you will pay back with less interest (about 24%). If you pay back in two years, you will pay back with higher interest (about 48%).

Paying back within 12 months			Paying back within 24 months		
Loan amount	**Interest**	**Monthly payment**	**Loan amount**	**Interest**	**Monthly payment**
10,000	2,400.00	1,033.33	10,000	4,800.00	616.67
20,000	4,800.00	2,066.67	20,000	9,600.00	1,233.33
30,000	7,200.00	3,100.00	30,000	14,400.00	1,850.00
40,000	9,600.00	4,133.33	40,000	19,200.00	2,466.67
50,000	12,000.00	5,166.67	50,000	24,000.00	3,083.33
60,000	14,400.00	6,200.00	60,000	28,800.00	3,700.00
70,000	16,800.00	7,233.33	70,000	33,600.00	4,316.67
80,000	19,200.00	8,266.67	80,000	38,400.00	4,933.33
90,000	21,600.00	9,300.00	90,000	43,200.00	5,550.00
100,000	24,000.00	10,333.33	100,000	48,000.00	6,166.67

Notes: The interest and monthly payments were based on 24% interest for a one year loan and 48% for a two years loan to make it easier for survey respondents to understand the microfinance option. In reality, the total interest to be paid would be lower if calculated based on the loan balance at the end of each month.

Appendix 4: Socioeconomic indicators of demand for ecosan (n=1217)

Variable	*n*	Pour flush/septic		Lined pit latrine		Pit latrine, cement floor		Unimproved sanitation		Pit emptying service	
		RRR	95% Conf.int	RRR	95% Conf.int	RRR	95% Conf.int	RRR	95% Conf.int	RRR	95% Conf.int
Income status of property owner											
MK>40,000 (ref)	402										
<MK20,000	396	0.2*	0.1-0.6	1.0	0.5-1.7	1.8*	1.1-2.9	7.3***	3.3-16.0	0.6	0.3-1.1
MK20,000 - MK40,000	419	0.3*	0.2-0.8	1.5	0.9-2.5	1.8*	1.2-2.9	3.2*	1.4-7.3	1.1	0.6-1.9
Type of pit latrine in use											
Pit latrine, cement floor (ref)	633										
Unimproved sanitation (mud floor)	345	0.6	0.2-1.5	2.1*	1.2-3.6	0.6*	0.4-1.0	27.9***	13.0-60.0	0.3*	0.1-0.6
No sanitation facility	19	0.0	0.000	1.1	0.2-5.0	0.3	0.1-1.2	5.9***	1.3-26.0	0.0	
Lined pit latrine	220	1.4	0.6-3.6	3.3***	1.7-6.5	0.04***	0.01-0.2	1.1	0.2-5.7	13.2***	7.1-24.3
Number of houses at a property		0.9	0.8-1.1	1.1	1.0-1.2	1.0	0.9-1.1	1.0	0.9-1.1	1.0	0.8-1.1
Access to a garden											
No	806										
Yes	411	0.5	0.3-1.0	0.8	0.5-1.3	0.7	0.5-1.1	0.9	0.5-1.5	0.5*	0.3-0.9
Has piped water on the yard											
No	628										
Yes	338	2.4*	1.2-4.7	1.9*	1.2-3.1	1.2	0.8-1.8	0.7	0.3-1.4	1.0	0.6-1.6
Knowledge of ecological sanitation											
No (ref)	399										
Yes	818	0.5*	0.3-0.9	0.8	0.5-1.3	0.8	0.5-1.3	0.7	0.4-1.1	0.8	0.5-1.4
_cons		1.6	0.5-5.1	1.8	0.7-4.2	0.1*	0.0-0.5	0.1*	0.0-0.3	1.4	0.7-2.8

Notes: survey respondents with ecological sanitation removed from analysis. The model was built using choices survey respondents made before they were offered microfinance. * p <0.05, *** p < 0.0001, Probability chi2 = 0.000, LR chi2 (45) =965.12, Pseudo R-squared =0.24

Appendix 5: Binary logistic regression models

Appendix 5.1: Binary logistic regression based on data only from respondents that had prior knowledge of ecological sanitation and based on choices respondents made after they were offered microfinance for sanitation (n=413)

Variable	Coef.	p-value	95% Conf. int	
Ecological sanitation is too involving to use	-0.1	0.701	-0.4	0.3
Inconvenience of emptying and handling human excreta	-0.4	0.022	-0.8	-0.1
Incompatibility with multiple users	-0.3	0.032	-0.6	0.0
Other benefits	-0.1	0.425	-0.4	0.2
permanency and safety	-0.1	0.671	-0.3	0.2
Influence of other people	0.0	0.985	-0.2	0.2
Affordability	-0.7	0.000	-0.9	-0.4
_cons	-1.6	0.000	-1.9	-1.3

LR chi2 (7) = 48.8, probability >chi2 = 0.000, Pseudo R-squared = 0.11

Appendix 5.2: Binary logistic regression model based on data only from respondents that had prior knowledge of ecological sanitation and based on choices respondents made before they were offered microfinance for sanitation (n=413)

Variable	Coef.	p-value	95% Conf. int	
Ecological sanitation is too involving to use	0.1	0.550	-0.3	0.6
Inconvenience of emptying and handling human excreta	-0.5	0.084	-1.1	0.1
Incompatibility with multiple users	-0.7	0.006	-1.2	-0.2
Other benefits	-0.1	0.532	-0.6	0.3
permanency and safety	-0.2	0.330	-0.5	0.2
Influence of other people	-0.2	0.266	-0.6	0.2
Affordability	-1.4	0.000	-1.8	-1.0
_cons	-3.5	0.000	-4.2	-2.8

LR chi2 (7) =75.8, probability >chi2 = 0.000, Pseudo R-squared =0.30

Appendix 5.3: Binary logistic regression model based on data only from respondents that were planning to construct new sanitation facilities within one year after being interviewed and based on choices made after microfinance for sanitation was offered (n=156)

Variable	Coef.	p-value	95% Conf. int	
Ecological sanitation is too involving to use	-0.7	0.11	-1.5	0.1
Inconvenience of emptying and handling human excreta	-0.4	0.199	-1.0	0.2
Incompatibility with multiple users	0.0	0.983	-0.5	0.5
Other benefits	0.0	0.918	-0.5	0.5
permanency and safety	0.1	0.733	-0.5	0.8
Influence of other people	0.1	0.587	-0.3	0.5
Affordability	-0.7	0.000	-1.2	-0.3
_cons	-1.7	0.000	-2.3	-1.2

LR chi2 (7) =24.44, probability >chi2 = 0.001, Pseudo R-squared =0.15

Appendix 5.4: Binary logistic regression model based on data from respondents that were planning to construct new sanitation facilities within one year after being interviewed and based on choices made before microfinance was offered (n=156)

Variable	Coef.	p-value	95% Conf. int	
Ecological sanitation is too involving to use	-1.2	0.214	-3.0	0.7
Inconvenience of emptying and handling human excreta	-0.4	0.362	-1.4	0.5
Incompatibility with multiple users	-0.4	0.356	-1.3	0.5
Other benefits	0.3	0.496	-0.5	1.1
permanency and safety	-0.2	0.733	-1.1	0.8
Influence of other people	-0.1	0.794	-0.6	0.5

Affordability	-1.5	0.000	-2.2	-0.8
_cons	-3.8	0.000	-5.2	-2.4

LR chi2 (7) = 36.60, Probability> chi2 = 0.000, Pseudo R-squared = 0.35

Appendix 5.5: Binary logistic regression based on data only from respondents that were planning to construct new sanitation facilities within two years after being interviewed and based on choices made after microfinance was offered (n=265)

Variable	Coef.	p-value	95% Conf. int	
Ecological sanitation is too involving to use	-0.4	0.173	-0.9	0.2
Inconvenience of emptying and handling human excreta	-0.3	0.158	-0.8	0.1
Incompatibility with multiple users	0.0	0.955	-0.4	0.4
Other benefits	0.0	0.876	-0.4	0.4
permanency and safety	0.2	0.387	-0.3	0.8
Influence of other people	0.2	0.207	-0.1	0.5
Affordability	-0.8	0.000	-1.1	-0.5
_cons	-1.8	0.000	-2.3	-1.4

LR chi2 (7) = 41.1, Probability> chi2 = 0.000, Pseudo R-squared = 0.16

Appendix 5.6: Binary logistic regression model based on data only from respondents that were planning to construct new sanitation facilities within two years after being interviewed and based on choices made before microfinance was offered (n=265)

Variable	Coef.	p-value	95% Conf. int	
Ecological sanitation is too involving to use	-0.4	0.336	-1.2	0.4
Inconvenience of emptying and handling human excreta	-0.4	0.328	-1.1	0.4
Incompatibility with multiple users	-0.4	0.175	-1.1	0.2
Other benefits	0.0	0.962	-0.6	0.6
permanency and safety	0.2	0.708	-0.6	0.9
Influence of other people	-0.1	0.838	-0.5	0.4
Affordability	-1.5	0.000	-2.0	-0.9
_cons	-3.7	0.000	-4.6	-2.7

LR chi2 (7) = 53.3, Probability> chi2 = 0.000, Pseudo R-squared = 0.34

Appendix 6: Drivers of Demand for Ecosan, Blantyre City

This section presents a detailed analysis of the drivers of demand for ecological sanitation and barriers affecting the adoption of the technology in Blantyre City. The study approach was similar to the approach discussed in chapter 5. The descriptive statistics for Blantyre city are shown on table 6.14. Most properties had pit latrines with cement floor (34%) and unimproved sanitation (32%). Properties that had lined pit latrines were fewer (29%). Only 2% (16) of the properties had ecological sanitation and only one property owner had pour flush toilet.

Positive and negative attributes of ecological sanitation in Blantyre City

In Blantyre city, property owners evaluated 7 positive attributes of ecological sanitation (table 7.8). The results show that nearly 100% liked the concept of ecological sanitation because it is permanent, less likely to collapse, safer for children to use and because it does not smell. Access to compost (soil conditioner) – a key feature of ecological sanitation was the least important positive attribute. Thirty eight percent indicated that access to compost would not motivate them to adopt ecological sanitation.

Table 7.8: Positive attributes of ecological sanitation, Blantyre City (n=634)

Item #	**Positive attributes/motivation**	Likert scale collapsed into binary response	
		Agree	Disagree
1	I would be motivated to adopt because it is safer for children.	98%	2%
2	I would be motivated to adopt because it is permanent.	97%	3%
3	I would be motivated to adopt because it will not collapse.	97%	3%
4	I would be motivated to adopt because it does not smell.	96%	4%
5	I would be motivated to adopt because it is cheaper to empty.	89%	11%
6	I would be motivated to adopt because it would make me look modern.	77%	23%
7	Access to compost would motivate me to adopt.	62%	38%

Note: Sample excludes respondents that had access to ecological sanitation.

Property owners in Blantyre City also evaluated 8 negative attributes of the technology (table 7.9). Seventy seven percent indicated that they could not afford to install

ecological sanitation, 28% indicated that the number of people at their property would stop them from adopting the technology and 16% indicated that handling compost from human excreta was disgusting.

Table 7.9: Negative attributes of ecological sanitation, Blantyre City (n=634)

Item #	**Negative attributes/barriers**	4 point likert scale collapsed into binary response	
		Agree	Disagree
1	The installation cost would stop me from adopting.	77%	23%
2	The number of people on my plot would stop me from adopting.	28%	72%
3	Lack of access to a garden would stop me from adopting.	24%	76%
4	Handling compost from human excreta is disgusting.	16%	84%
5	The shallow depth would stop me from adopting.	11%	89%
6	The task of emptying the facility would stop me from adopting	9%	91%
7	The task of adding ash is too involving.	8%	92%
8	The task of adding soil is too involving	7%	93%

Note: Sample excludes respondents that had access to ecological sanitation.

Attitude towards access to compost from human excreta

There were differences in attitude towards the technology among property owners with different socioeconomic and demographic characteristics (table 7.10). Column 1 of table 7.10 shows that property owners that had access to a garden were 8.5 times more likely to perceive that access to compost from human excreta was a positive attribute than property owners that did not have access to a garden ($p<0.001$). Column 1 also shows that property owners in the highest income category were less likely to perceive that access to compost from human excreta as a positive attribute than property owners in the lowest income category (OR = 0.4, $p<0.001$). Column 1 further shows that property owners that had access to lined pit latrine were less likely to perceive access to compost as a motivating attribute ($p<0.001$) than property owners that did not have lined pit latrines. Column 2 of the table shows that property owners in the highest income compared to property owners in the lowest income category were 1.8 times more likely to perceive that the task of handling compost from human excreta was disgusting ($p=0.03$). Column 2 also shows that property owners that were using lined pit latrines compared to those without lined pit latrines were 1.6 times more likely to perceive that the task of handling compost from human excreta was disgusting ($p=0.03$).

Table 7.10: Characteristics of property owners likely to dislike handling human excreta

Variable	n	*Column 1*			*Column 2*		
		Access to compost from human excreta will motivate me to adopt			Handling compost from human excreta is disgusting		
		OR	P-value	95% Conf. int.	OR	P-value	95% Conf.int
Access to a garden							
No access (ref)	323						
Had access	279	8.5	0.00	5.8 - 12.8	0.7	0.1	0.4 - 1.0
Income status of property owner							
<MK20,000	202						
MK20,000 - MK40, 000	215	1.0	0.90	0.6- 1.5	0.8	0.4	0.5 - 1.4
> MK40,000	185	0.4	0.00	0.3 - 0.6	1.8	0.03	1.1- 2.9
Education of property owner							
No education (ref)	25						
Primary school	237	0.6	0.25	0.2-1.5	1.1	0.9	0.3 - 3.2
Secondary school	281	0.6	0.30	0.2-1.5	1.1	0.9	0.4 - 3.4
College	59	0.4	0.07	0.1-1.1	1.6	0.5	0.5 - 5.4
Knowledge about ecosan							
No prior knowledge (ref)	198						
Had prior knowledge	404	0.9	0.50	0.6-1.3	1.0	0.9	0.6 - 1.5
Presence of tenants							
No tenants (ref)	239						
Tenants	363	0.7	0.06	0.5 - 1.0	1.3	0.3	0.8 - 2.0
Access to a lined pit latrine							
Unlined pit latrine (ref)	419						
Had a lined pit latrine	183	0.5	0.00	0.3-0.7	1.6	0.03	1.0 - 2.5
Gender of property owner							
Female (ref)	165						
Male	437	0.6	0.01	0.4 - 0.9	1.6	0.1	0.9-2.6

Notes: Results from univariable binary logistic regression. (n=601), this sample excludes 16 respondents that were using ecological sanitation. The sample also excludes 32 respondents due to data inconsistency.

Attitude towards the task of adding ash, soil and emptying ecological sanitation

Table 7.11 shows differences in attitude towards the tasks of adding ash, soil and emptying the technology when it fills up. Columns 1, 2 and 3 show that property owners that had access to a garden compared to those without a garden were less likely to perceive that the task of adding ash, soil and emptying ecological sanitation were too involving (P<0.001). Column 1 further shows that property owners in the highest income category were 2.4 times more likely to perceive that the task of adding ash into the vaults of ecological sanitation facilities was too involving (p=0.01).

Table 7.11: Characteristics of property owners likely to dislike the operation of ecological sanitation

Variable	n	Column 1			Column 2			Column 3		
		The task of adding ash is too involving			The task of adding soil is too involving			The task of emptying the facility would stop me from adopting		
		OR	P-value	95% Conf. int.	OR	P-value	95% Conf.int	OR	P-value	95% Conf. int
Access to a garden for food production										
No access (ref)	323									
Had access	279	0.3	0.00	0.1 - 0.6	0.2	0.00	0.1 - 0.5	0.4	0.00	0.2 - 0.8
Income status of property owner										
<MK20,000	202									
MK20,000 - MK40, 000	215	0.9	0.80	0.4 - 2.0	1.1	0.8	0.5 - 2.6	0.8	0.5	0.4 - 1.5
> MK40,000	185	2.4	0.01	1.2 - 5.0	1.9	0.1	0.9 - 4.1	1.1	0.9	0.5 - 2.1
Education status of property owner										
No education (ref)	25									
Primary school	237	1.7	0.60	0.2 - 13.3	1.8	0.6	0.2 - 14.2	1.3	0.7	0.3 - 5.8
Secondary school	281	2.0	0.50	0.3 - 15.3	1.9	0.5	0.2 - 14.9	1.2	0.8	0.3 - 5.2
College education	59	6	0.10	0.7 - 47.9	2.4	0.4	0.3 - 21.3	1.4	0.7	0.3 - 7.4
Knowledge of ecological sanitation										
No prior knowledge (ref)	198									
Had prior knowledge	404	0.9	0.70	0.5 - 1.6	1.2	0.5	0.6 - 2.5	1	0.9	0.5 - 1.7
Presence of tenants at the property										
No tenants (ref)	239									
Had tenants	363	1.9	0.10	1.0- 3.6	1.9	0.1	1.0 - 3.9	1.2	0.5	0.7 - 2.1
Access to a lined pit latrine										
No (ref)	419									
Had a lined pit latrine	183	1.6	0.10	0.9 - 2.9	2.1	0.03	1.1 - 3.8	1.7	0.1	1.0 - 3.0
Gender of property owner										
Female (ref)	165									
Male	437	2.4	0.04	1.0 - 5.3	1.4	0.4	0.7 - 3.1	1.1	0.6	0.6 - 2.2

Notes: Results from univariable binary logistic regression. (n=601), this sample excludes 16 respondents that were using ecological sanitation. The sample also excludes 32 respondents due to data inconsistency.

Key drivers of demand and barriers affecting the adoption of ecological sanitation

Table 7.12 shows a multivariable binary logistic regression model built using choices made before survey respondents were offered microfinance for sanitation and using the choices of respondents that had prior knowledge of ecological sanitation. The results show that intention to adopt ecological sanitation was negatively associated with the installation cost of the technology (Coef = - 1.5, p<0.001).

Table 7.12: Adoption barriers, Blantyre City (n=402)

Variable	Coef.	p-value	95% Conf.	
Access to compost would motivate me to adopt	0.4	0.17	-0.2	1.0
Lack of smell would motivate me to adopt	0.2	0.79	-1.0	1.3
I would be motivated to adopt because it will make me look modern	0.0	0.97	-0.8	0.8
I would be motivated to adopt because it is cheaper to empty	-0.1	0.75	-0.8	0.6
lack of access to a garden would stop me from adopting	-0.4	0.35	-1.4	0.5
Handling compost from human excreta is disgusting.	0.6	0.15	-0.2	1.3
The task of adding ash is too involving.	-2.5	0.40	-8.2	3.3
The task of adding soil is too involving	0.2	0.94	-4.1	4.4
The task of emptying the facility would stop me from adopting	1.0	0.14	-0.3	2.2
The number of people on my plot would stop me from adopting.	-0.8	0.06	-1.7	0.0
The shallow depth would stop me from adopting.	0.1	0.90	-0.9	1.0
The installation cost would stop me from adopting.	-1.5	0.00	-2.2	-0.8
_cons	1.0	0.70	-4.3	6.3

Notes: Results from multivariable binary logistic regression. Model based on choices respondents made before microfinance was offered. Sample excludes respondents that had no prior knowledge of ecological sanitation, those with access to ecological sanitation (16) and those rejected because of inconsistency of their data (32). Probability chi2 = 0.000, LR chi (12) =59, Pseudo R-squared = 0.39

Table 7.13 shows a multivariable binary logistic model built using choices survey respondents made after they were offered microfinance for sanitation. The model was based on the choices of survey respondents that had prior knowledge of ecological sanitation. The table shows that intention to adopt ecological sanitation was negatively associated with the installation cost of the technology (p<0.001) and the number of people at a plot/property (p=0.05).

Table 7.13: Adoption barriers if microfinance was offered, Blantyre City (n=402)

Variable	Coef.	p-value	95% Conf.	
Access to compost would motivate me to adopt	0.13	0.40	-0.15	0.41
Lack of smell would motivate me to adopt	0.33	0.30	-0.30	0.97
I would be motivated to adopt because it will make me look modern	0.00	0.90	-0.33	0.33
I would be motivated to adopt because it is cheaper to empty	0.27	0.20	-0.19	0.73
lack of access to a garden would stop me from adopting	-0.38	0.06	-0.79	0.02
Handling compost from human excreta is disgusting.	0.02	0.90	-0.39	0.42
The task of adding ash is too involving.	-0.16	0.70	-1.07	0.75
The task of adding soil is too involving	-0.70	0.30	-2.02	0.62
The task of emptying the facility would stop me from adopting	0.26	0.40	-0.32	0.85
The number of people on my plot would stop me from adopting.	-0.31	0.05	-0.6	-0.01
The shallow depth would stop me from adopting.	-0.055	0.80	-0.5	0.4
The installation cost would stop me from adopting.	-0.353	0.00	-0.6	-0.1
_cons	-1.396	0.30	-4.3	1.5

Note: Results from multivariable binary logistic regression. Analysis based on choices made after microfinance was offered. Model excludes respondents with access to ecological sanitation (16) and those rejected because of inconsistency of their data (19).

Appendix 7: Proposed in-depth interview guide.

Consent form

Hello, my name is _____ [*name of interviewer*] and I am working with_____ [*name of organisation*] to promote improved sanitation and alternative sanitation technologies. *Are you the property owner? Ask for the owner.*

Purpose of the research: I was hoping that you might have 2 hours to spare to share with me what you think about alternative sanitation technologies and pit emptying services. Hopefully we can learn about your sanitation needs.

What you will do in this research: If you decide to take part in this interview, I will ask you several questions about your current sanitation facility, what you think about alternative sanitation technologies and pit emptying services.

Time required: The interview will take approximately 2 hours.

Benefits: This is a chance for you know more about alternative sanitation technologies and to tell your story about how you cope with the challenges of pit latrines and the services you are looking for.

Confidentiality: Your responses to interview questions will be kept confidential. At no time will your actual identity be revealed. You will be assigned a random numerical code. Anyone who will process the responses will only know you by this code. The data you will provide will be used in a research report and may be used as the basis for articles or presentations in the future. Your name/s or information that would identify you in any publications or presentations will not be used.

Participation and withdrawal: Taking part in this study is completely voluntary, and you may withdraw from the study at any time. You may withdraw by informing me that you no longer wish to continue (no questions will be asked)

Agreement:
The nature and purpose of this research have been sufficiently explained and I agree to take part in this study. I understand that I am free to withdraw at any time.

☐ I agree to be recorded
☐ I do not want to be quoted at all
☐ I agree to be quoted but I must see the quotation first
☐ I agree to be quoted if my name is not published (I remain anonymous)

Date	
Name of respondent	
Signature of respondent	
Location	

In-depth interview guide – examining demand for alternative sanitation

	Current technology and desire for change
1.	What sanitation technology are you using?
2.	Have you ever thought about adopting a different type of sanitation technology?
3.	What type of sanitation technology have you thought about?
4.	Why would you want to adopt this type of technology?
5.	What is stopping you from adopting this technology?
	Concern about space for sanitation
6.	Are you concerned about space for replacing pit latrines? If no, ask why
7.	If yes, ask (a) ask what is the cause? (b) How do you plan to address this concern?
	Challenges associated with pit latrines
8.	Do you have any problems with pit latrines here?
9.	If yes, ask (a) What is the cause? (b) How do you plan to address these problems?
	Knowledge about alternative sanitation technologies
10.	What other sanitation technologies do you know?
11.	Out of the other sanitation technologies you know, (a) which technology would you adopt and why? (b) Which technologies would you reject, why?
12.	**Discuss alternative technologies**
13.	Show pictures of pour flush toilets, urine diverting toilets, fossa alterna lined pit latrine and a slab. Discuss operation, advantages, disadvantages and cost
	Ecological sanitation
14.	What do you think about ecosan/composting toilets?
15.	What could motivate you to adopt ecosan/composting toilets?
16.	What could stop you from adopting ecosan/composting toilets?
	Pour flush toilets
17.	What do you think about pour flush toilets? What could motivate you to adopt pour flush toilets and what could stop you?
	Lined pit latrines
18.	What do you think about lined pit latrines? What could motivate you to adopt a lined pit and what could stop you?
	Pit emptying
19.	Have you ever emptied your facility or ever thought about emptying your facility?
20.	What do you think about emptying your current pit latrine?
21.	What could motivate you to empty your current latrine and what could stop you?
	Technology choice and reasons for selecting a particular technology
22.	*If you had the following options:* empty the current facility, install unimproved sanitation, install a pit latrine with cement floor, install a lined pit latrine OR adopt ecosan or pour flush toilet; What option would you choose, why?
23.	What option would you choose for your tenants and why?

Appendix 8: Proposed survey questionnaire.

CONSENT

Hello, my name is _____ [*name of interviewer*] and I am working with_____ [*name of organisation*] to promote access to safe and sustainable sanitation in this community. *Are you the property owner?*

Purpose of the research: I was hoping that you might have 2 hours to spare to share with me what you think about alternative sanitation technologies and pit emptying services. Hopefully, we can learn about your sanitation needs and the technology and services you desire.

What you will do in this research: If you decide to take part in this interview, I will ask you several questions about alternative sanitation technologies and pit emptying services. I will aslo ask you several questions about how you address or intend to address some of the limitations of pit latrines e.g. lack of space for replacing them, high groundwater table or shallow bedrock.

Time required: The interview will take approximately 2 hours.

Benefits: This is a chance for you know more about alternative sanitation technologies and to tell your story about how you cope with the challenges associated with of pit latrines.

Confidentiality: Your responses to interview questions will be kept confidential. At no time will your actual identity be revealed. You will be assigned a random numerical code. Anyone who will process the responses will only know you by this code. The data you will provide will be used in a research report and may be used as the basis for articles or presentations in the future. Your name will not be used.

Participation and withdrawal: Taking part in this study is completely voluntary, and you may withdraw from the study at any time without any penalty. You may withdraw by informing me that you no longer wish to continue.

Agreement:
The nature and purpose of this research have been sufficiently explained and I agree to take part in this study. I understand that I am free to withdraw at any time.

Date	
Name of respondent	
Gender of respondent	
Signature of respondent	
Location	

EXAMINING DEMAND FOR ALTERNATIVE SANITATION TECHNOLOGIES IN LOW-INCOME URBAN AREAS

PART 1: SANITATION TECHNOLOGIES IN USE

1. What type of type of sanitation facilities are you using at this property? *Tick technologies in use*

1. ☐ Pit latrine slab (slab can be shifted/relocated)
2. ☐ Pit latrine cement floor (slab cannot be shifted)
3. ☐ Pit latrine with a mud floor
4. ☐ Latrine with lined pits
5. ☐ Pour flush toilet
6. ☐ Urine diverting toilet
7. ☐ Fossa alterna [ ]
8. ☐ Septic tank
9. ☐ No sanitation facility
10. ☐ Other: specify_____

Number of sanitation facilities in use: [ ]

2. Do you have tenants? 1. ☐ Yes 2. ☐ No [ ]

3. If there are tenants, What type of sanitation do your tenants use?

1. ☐ Pit latrine slab
2. ☐ Pit latrine cement floor
3. ☐ Pit latrine with a mud floor
4. ☐ Lined pit latrine
5. ☐ Pour flush toilet
6. ☐ Urine diverting toilet
7. ☐ Fossa alterna [ ]
8. ☐ Septic tank
9. ☐ No sanitation facility
10. ☐ Other –specify:_____
11. ☐ No tenants

PART 2: PLANS FOR ADDRESSING ENVIRONMENTAL CONCERNS

4. How concerned are you about space for sanitation, facilities. Please responding to the following:

a. When my current facility fills up, there is no space for a replacement facility [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

b. There is enough space for new sanitation facilities [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

c. I am concerned about space for replacing my current sanitation facility. [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

If respondent is concerned about space for replacing pit latrines (agrees or strongly agrees to 4c), ASK, how do you intend to address the problem of space for replacing pit latrines? do not read out options
Note: Don't read out options

1. ☐ Adopt ecological sanitation *e.g. urine diverting toilet, fossa alterna)*
*Specify type of ecological sanitation:*_____
2. ☐ Adopt pour flush toilet
3. ☐ Adopt a septic tank toilet
4. ☐ Improve the build quality of pit latrine *e.g. deep pit, roofing, slab/cement floor* [ ]
Specify the type of improvement:_____
5. ☐ Adopt lined pit latrine
6. ☐ Construct new pit latrine on a bathroom spot
7. ☐ Construct new pit latrine on an old pit latrine spot
8. ☐ Other strategy – *specify:* _____
9. ☐ Empty current pit latrine

5. How concerned are you about high groundwater table? Please respond to the following:

a. There is a problem of high groundwater at this property. [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

b. Latrine pits at this property collapse because of high groundwater table. [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

c. I cannot dig deep latrines because of high groundwater table [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

d. I am concerned about high groundwater table [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

*If respondent is concerned about high groundwater table (agrees or strongly agrees to 5d)- **ASK** How do you intend to address this problem*

1. ☐ Adopt ecological sanitation *e.g. urine diverting toilet, fossa alterna)*
*Specify type of ecological sanitation:*_____ [ ]
2. ☐ Adopt pour flush toilet
3. ☐ Adopt a septic tank toilet

4. ☐ Adopt pour flush toilet
☐ Improve the build quality of pit latrine *e.g. deep pit, roofing, slab/cement floor Specify the type of improvement*:_____
5. ☐ Adopt lined pit latrine
6. ☐ Other strategy – *specify:* _____
7. ☐ No strategy
8. ☐Empty current pit

6. How concerned are you about shallow bedrock? Please respond to the following statements:

a. There is a problem of shallow bedrock at this property. [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

b. I am concerned when digging latrine pits because of shallow bedrock [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

c. I fail to dig deep pits because of shallow bedrock [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

d. It is difficult to dig latrine pits at this property because of shallow bedrock [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

*If pit latrines are difficult to dig because of shallow bedrock - **ASK –*** How do you intend to address this problem

1. ☐ Adopt ecological sanitation *e.g. urine diverting toilet, fossa alterna)*
*Specify type of ecological sanitation:*_____
2. ☐ Adopt pour flush toilet
3. ☐Adopt a lined pit latrine
4. ☐ Adopt a septic tank toilet
5. ☐ Improve the build quality of pit latrine *e.g. deep pit, roofing, slab/cement floor*
Specify the type of improvement:_____ [ ]
6. ☐ Adopt lined pit latrine
7. ☐ Other strategy – *specify:* _____
8. ☐ No strategy
9. ☐Empty current facility

7. How concerned are you about collapsing of latrine pits when digging? Please respond to the following:

a. There are spots where I have never dug pit latrines before [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

b. I have dug latrine pits on all the spaces available [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

c. When current latrine fills up, I will dig new latrine pit on an old pit latrine spot [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

d. I am concerned that the walls of pit latrines will collapse when digging. [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

*If respondent is concerned about type of soil – **ASK -*** How do you intend to address this problem?

1. ☐ Adopt ecological sanitation *e.g. urine diverting toilet, fossa alterna)*
*Specify type of ecological sanitation:*_____
2. ☐ Adopt pour flush toilet
3. ☐ Adopt a lined pit latrine
4. ☐ Adopt a septic tank toilet
5. ☐ Improve the build quality of pit latrine *e.g. roofing, slab/cement floor*
Specify the type of improvement:_____ [ ]
6. ☐ Adopt lined pit latrine
7. ☐ Other strategy – *specify:* _____
8. ☐ No strategy
9. ☐ Empty current facility

PART 3: EVALUATION OF CURRENT SANITATION FACILITY

NOTE: *If there are multiple technologies e.g. ecological sanitation and a pit latrine or pour flush and a pit latrine Ask this question for each technology but use separate sheets/questionnaire.*

8. How satisfied are you with your current sanitation facility [ ]
1.☐Very dissatisfied 2. ☐Dissatisfied 3. ☐Satisfied 4. ☐Very satisfied

Type of technology being assessed:_____

a. My sanitation facility does not smell. [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

b. My sanitation facility does not produce flies. [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

c. My sanitation facility is pleasant to use [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

d. My sanitation facility suits the number of people at the property. [ ]
1☐Strongly Disagree. 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

e. My sanitation facility suits the number of households at the plot. [ ]
1☐Strongly Disagree, 2 ☐Disagree, 3☐Agree 4☐Strongly Agree.

f. My sanitation facility is suitable for multiple households. [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

EASE OF USE

g. Children can use the sanitation facility properly [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

h. The sanitation facility is easy for children to use. [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

i. My sanitation facility is safe for children to use. [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

j. I am scared when children use the facility. [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

k. Tenants have difficulties to use the facility. [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

l. The sanitation facility is easy for tenants to use. [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

m. The facility is not too involving for tenants to use. [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

n. The facility is not suitable for tenants. [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

PERMANENCY OF CURRENT SANITATION FACILITY

o. My sanitation facility cannot collapse. [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

p. My sanitation facility is permanent [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

q. I will use my sanitation facility for many years. [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

PREFERENCE FOR PIT EMPTYING

r. I designed my facility to be emptying it. [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

s. The quality of my facility is too good to pull it down and construct another one [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

t. My sanitation facility may collapse if emptied. [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

u. If I empty my current facility, it will fill up within a short time [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

v. If I empty my current facility, I will only be able to use it for short time [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

w. It will be better to empty my facility when it fills up than build another one. [ ]

	1☐Strongly Disagree, 2. ☐Disagree, 3☐Agree 4☐Strongly Agree
x.	It will be cheaper to empty current facility than build another one [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
y.	It will be better to build another sanitation facility than empty the current one [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
z.	I can afford to empty my sanitation facility. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
	KNOWLEDGE ABOUT PIT EMPTYING SERVICE PROVIDERS
aa.	I know people that can empty my sanitation facility. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
bb.	I know where to find people that empty sanitation facilities. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
cc.	Finding people that can empty sanitation facilities is easy. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
dd.	When my facility fills up, I shall empty it [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
	Note: for households without ecological sanitation, skip x to z and move to part 3
ee.	Cheap fertiliser (compost) from my sanitation facility is important to me. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
ff.	I have use for the cheap fertilizer (compost) from my sanitation facility. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
gg.	I do not throw away the cheap fertiliser (compost) from the facility [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

PART 4: DESIRE TO CHANGE TYPE OF SANITATION FACILITY

9.	I have contemplated adopting a different type of sanitation facility [ ] 1☐Strongly Disagree 2☐Disagree 3☐Agree 4☐Strongly Agree
10.	I have made enquiries about a different type of sanitation [ ] 1☐Strongly Disagree 2☐Disagree 3☐Agree 4☐Strongly Agree
11.	When my current sanitation facility fills up, I will adopt a different type of facility [ ] 1☐Strongly Disagree 2☐Disagree 3☐Agree 4 ☐Strongly Agree
12.	I am planning to adopt a different type of sanitation technology [ ] 1☐Strongly Disagree 2☐Disagree 3☐Agree 4 ☐Strongly Agree
	If respondent agrees or strongly agrees to question 12; Describe the type of technology you are you planning to adopt: _____

PART 5: SANITATION TECHNOLOGY CHOICES

13.	When your current sanitation facility fills up, what are you planning to do? [ ] 1. ☐ Emptying current sanitation facility 2. ☐ Construct another *(compare response to question 12 & 8bb)* If emptying go to question 14, if intention is to construct another sanitation facility go to question 15
14.	If respondent intends to empty current sanitation facility, ASK – how do you plan to empty your facility? 1. ☐Gulper 2. ☐Vacuum tanker 3. ☐Dig another pit next to the full pit and join the pits to empty by gravity [ ] 4. ☐Scooping with buckets 5. ☐Has ecosan facility 6. ☐Using a chemical

15. If respondent intends to construct another facility – ASK – What technology are you planning to construct?
Tick options mentioned (do not read out options)

1. ☐ Pit latrine slab floor *(floor can be shifted to another location)*
2. ☐ Pit latrine cement floor *(floor cannot be shifted to another spot)*
3. ☐ Pit latrine - mud floor
4. ☐ Lined pit latrine
5. ☐ Pour flush toilet [ ]
6. ☐ Urine diverting toilet
7. ☐ Fossa alterna
8. ☐ Septic tank
9. ☐ Other: _____

How are you planning to construct this facility? [ ]
1. ☐ By cash 2. ☐ Through a loan 3. ☐ Partly cash & partly loan

*If the answer is loan or partly loan – **ASK** -*Where are you planning to get this loan from

1. ☐ Microfinance institution: Name _____
2. ☐ NGO: Name_____ [ ]
3. ☐ Friend
4. ☐ Family

If emptying would cost you MK 20,000 what would you do?	If emptying would cost you MK 10,000 what would you do?	If emptying would cost you MK 30,000 what would you do?
1. ☐ I would empty 2. ☐ construct another: Specify technology: 1. ☐ Pit latrine slab 2. ☐ Pit latrine cement floor 3. ☐ Pit latrine - mud floor 4. ☐ Lined pit latrine 5. ☐ Pour flush toilet *6.* ☐ Urine diverting toilet 7. ☐ Fossa alterna 8. ☐ Septic tank 9. ☐ Pit emptying 10. ☐ Other: *Other*_____	1. ☐ I would empty 2. ☐ construct another: Specify technology: 1. ☐ Pit latrine slab 2. ☐ Pit latrine cement floor 3. ☐ Pit latrine - mud floor 4. ☐ Lined pit latrine 5. ☐ Pour flush toilet *6.* ☐ Urine diverting toilet 7. ☐ Fossa alterna 8. ☐ Septic tank 9. ☐ Pit emptying 10. ☐ Other: *Other*_____	1. ☐ I would empty 2. ☐ construct another: Specify technology: 1. ☐ Pit latrine slab 2. ☐ Pit latrine cement floor 3. ☐ Pit latrine - mud floor 4. ☐ Lined pit latrine 5. ☐ Pour flush toilet *6.* ☐ Urine diverting toilet 7. ☐ Fossa alterna 8. ☐ Septic tank 9. ☐ Pit emptying 10. ☐ Other: *Other*_____

PART 6: MICROFINANCE FOR SANITATION

16. What do you think about access to microfinance for sanitation? Please respond to the following:

It is easy to get a loan to improve sanitation [ ]
1☐Strongly Disagree 2☐Disagree 3☐Agree 4 ☐Strongly Agree

I know where to go to get a loan for sanitation. [ ]
1☐Strongly Disagree 2☐Disagree 3☐Agree 4 ☐Strongly Agree

I know how to get a loan for sanitation [ ]
1☐Strongly Disagree 2☐Disagree 3☐Agree 4 ☐Strongly Agree

Imagine that there was an opportunity for a loan for you to build any sanitation technology of your choice. If the amount offered to be taken as loan ranged from MK10, 000 to MK120, 000. The loan is to be paid back within 1 or 2 years at an interest of 2% which is charged on your loan balance every month. The loan could only be offered to individuals planning to construct a new sanitation facility but not to empty their current sanitation facility. Show respondent the total interest and how much they will need to pay back every month to pay back the loan within 12 months (assume 24% interest) or within 24 months (assume 48% interest)

17. Would you be interested to take the loan? 1.☐Yes 2.☐No [ ]

18. If yes, what type of sanitation technology would you adopt? Do not read out options

1. ☐ Pit latrine slab
2. ☐ Pit latrine cement floor
3. ☐ Pit latrine - mud floor
4. ☐ Lined pit latrine
5. ☐ Pour flush toilet [ ]
6. ☐ Urine diverting toilet
7. ☐ Fossa alterna
8. ☐ Septic tank
9. ☐ Pit emptying, how?

10. ☐ Other technology_____

Now I want to know if you have knowledge about alternative sanitation technologies.
I will show you pictures of some alternative sanitation technologies and ask how much you know about these technologies.

19. I know the advantages and disadvantages of *fossa alterna toilets* [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
Explain the estimated cost of Fossa alterna toilet and its advantages and disadvantages using photographs

20. I know the advantages and disadvantages of *urine diverting toilets* [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
Explain the estimated cost of Urine diverting toilet its advantages and disadvantages using photographs

21. I know the advantages and disadvantages of a pour flush toilet [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

22. I know the advantages of emptying using a gulper [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

Explain the estimated cost of emptying latrines using a gulper and the quality of service (depth emptied)

23.	Considering the options we have discussed, what technology will you install when the facility you are using fills up, assuming you have **NO ACCESS** to microfinance?	Considering the options we have discussed, what technology will you install when the facility you are using fills up, assuming you have **ACCESS** to microfinance?
	1. ☐ Pit latrine slab [ ] 2. ☐ Pit latrine cement floor 3. ☐ Pit latrine - mud floor 4. ☐ Lined pit latrine 5. ☐ Pour flush toilet 6. ☐ Urine diverting toilet 7. ☐ Fossa alterna 8. ☐ Septic tank 9. ☐ Pit emptying i. ☐ Using a gulper ii. ☐ manually 10. ☐ Other technology: *Other*_____	1. ☐ Pit latrine slab [ ] 2. ☐ Pit latrine cement floor 3. ☐ Pit latrine - mud floor 4. ☐ Lined pit latrine 5. ☐ Pour flush toilet 6. ☐ Urine diverting toilet 7. ☐ Fossa alterna 8. ☐ Septic tank 9. ☐ Pit emptying, please indicate how i. ☐ Using a gulper ii. ☐ manually 10. ☐ Other technology *Other*_____

PART 7: PERCEPTIONS ABOUT ALTERNATIVE SANITATION TECHNOLOGIES

e.g. urine diverting toilet

25. *SKIP ACCESS TO COMPOST (a to d) IF THE FOCUS OF THE TECHNOLOGY IS NOT RECYCLING HUMAN EXCRETA*

ACCESS TO COMPOST

a. I need cheap fertiliser from human excreta [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

b. Access to cheap fertiliser from human excreta is useful to me [ ]
1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

c. I do not have any use for cheap fertiliser from human excreta [ ]

	1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
d.	Access to cheap fertiliser will motivate me to adopt [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
PLEASANT TO USE	
e.	This technology *(name of technology)* will make me look smart [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
f.	This technology will make me look clean [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
g.	Other people will admire me if I adopt this technology [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
h.	It's lack of smell will motivate me to adopt this technology [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
i.	It's lack of flies will motivate me to adopt this technology. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
j.	This technology will be pleasant to use. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
COMPLEXITY OF EMPTYING	
k.	This technology will be easy to empty. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
l.	Emptying this technology will not be too involving. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
m.	I would prefer to empty this technology myself together with other family members [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
n.	I would prefer to hire other people to empty it for me [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
o.	Emptying the technology will be too involving. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
p.	This technology is cheap to empty. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
q.	Emptying it will be affordable [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
r.	This technology is expensive to empty. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
COMPATIBILITY WITH MULTIPLE USERS	
s.	This technology is suitable for multiple households [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
t.	This technology is suitable for landlord only [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
u.	This technology is suitable for one household only [ ]
v.	This technology is not suitable for multiple households [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
EASE OF USE	
w.	This technology is easy to use [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
x.	This technology is too involving to use [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
y.	This technology is suitable for tenants [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
z.	Tenants can use this technology properly. [ ]

	1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
aa.	This technology is easy for tenants to use. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
bb.	Children can use this technology properly. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
cc.	This technology is easy for children to use. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
dd.	This technology would be difficult for children to use. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
ee.	This technology is not risky for children to use. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
ff.	This technology would be safer for children to use. [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
AFFORDABILITY & INTENTION	
gg.	I can afford this technology [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
hh.	I am sure that I can afford this technology [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
ii.	I know where and how to get the money to construct this technology [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
jj.	I cannot afford this technology [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
kk.	When my facility fills up, I shall adopt this technology [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree
ll.	When my facility fills up, I desire to adopt this technology [ ] 1☐Strongly Disagree, 2☐Disagree, 3☐Agree 4☐Strongly Agree

PART 8: HOUSEHOLD CHARACTERISTICS

Gender	Education	Main source of income	Income per month	Age	Religion
1.☐Male 2.☐Female	1.☐None 2.☐Primary 3.☐Secondary 4.☐College	1.☐Renting houses 2.☐Employment 3.☐Business	1.☐<10,000 2.☐11,00-20,000 3.☐21,000-30,000 4.☐31,000- 40,000 5.☐>40,000	1.☐<30 years 2.☐31-60 3.☐>60	1.☐Christian 2.☐Moslem 3.☐None

PART 9: OBSERVATIONS

26.	Property owner has a garden for food production in the city? 1.☐Yes 2.☐No [ ]
27.	Current sanitation facility has a roof? 1.☐Yes 2.☐No [ ]
28.	Bathroom water goes into the toilet? 1.☐Yes 2.☐No [ ]
29.	Sanitation facility built using bricks? 1.☐Yes 2.☐No [ ]
30.	Sanitation facility has a cement/slab floor? 1.☐Yes 2.☐No [ ]
31.	The floor/slab can be shifted and reused on another spot? 1.☐Yes 2.☐No [ ]
32.	There is a hand washing facility at the toilet? 1.☐Yes 2.☐No [ ]
33.	There is piped water on the yard? 1.☐Yes 2.☐No [ ]
34.	There is vacant space at the property?1.☐Yes 2.☐No [ ]
35.	There is electricity at the property? 1.☐Yes 2.☐No [ ]
36.	The house of property owner was built with bricks? 1.☐Yes 2.☐No [ ]
37.	Respondent has a radio? 1.☐Yes 2.☐No [ ]
38.	Respondent has a phone? 1.☐Yes 2.☐No [ ]

	Telephone Number of respondent
	Easting:
	Northing:
	Thank you very much; this is what I wanted to ask. Do you have any questions or comments? …….

Appendix 9: Property owners – in-depth interview guide used

Investigating Household Sanitation Technology Choices and Factors Affecting the Adoption of Ecosan in Low Income (peri-urban) Areas

Consent form

Hello, my name is _____and I am working with **WATERAID/WATER FOR PEOPLE** to support the development of a local sanitation industry that we hope will make it more desirable and easier for members of your community to invest in improved sanitation technologies. Are you the home owner at this compound? *[If no, ask to speak to the home owner]*

Purpose of the research: I was hoping that you might have 2 hours to spare to share with me your sanitation technology choices and what you think about ecosan and other alternative sanitation technologies. Hopefully then we can learn from your experiences and opinions to help encourage higher sanitation coverage in this area.

What you will do in this research: If you decide to take part in this interview, you will be asked several questions about your latrine, ecosan and other alternative sanitation technologies.

Time required: The interview will take approximately 2 hours.

Benefits: This is a chance for you know more about alternative sanitation technologies and to tell your story about the process of acquiring a sanitation facility, problems encountered and your opinions about alternative sanitation technologies.

Confidentiality: Your responses to interview questions will be kept confidential. At no time will your actual identity be revealed. You will be assigned a random numerical code. Anyone who will process the responses will only know you by this code. The questionnaire, without your name, will be kept for future references. The key code linking your name/s with your number will be kept in a locked file cabinet in a locked office, and no one else will have access to it. The data you will provide will be used in a research report and may be used as the basis for articles or presentations in the future. Your name/s or information that would identify you in any publications or presentations will not be used.

Participation and withdrawal: Taking part in this study is completely voluntary, and you may withdraw from the study at any time without penalty. You may withdraw by informing me that you no longer wish to participate (no questions will be asked). You may also skip any question during the interview, but continue to participate in the rest of the study.

Agreement:

The nature and purpose of this research have been sufficiently explained and I agree to take part in this study. I understand that I am free to withdraw at any time without incurring any penalty.

☐ I agree to be recorded
☐ I do not want to be quoted at all
☐ I agree to be quoted but I must see the quotation first
☐ I agree to be quoted if my name is not published (I remain anonymous)

Date	
Name of respondent	
Signature of respondent	
Location	

Type of sanitation technology in use		
1.	What type of sanitation do you have?	1. ☐ Traditional latrine, mud floor 2. ☐ Pit latrine with a cement floor 3. ☐ Pit latrine with a slab/Sanplat 4. ☐ Fossa alterna 5. ☐ Skyloo/Urine Diverting Toilet 6. ☐ Lined pit latrine 7. ☐ Pour flush 8. ☐ Ventilated improved 9. ☐ Septic
2.	What type of sanitation did you have before you built this current latrine?	1. ☐ Traditional latrine, mud floor 2. ☐ Pit latrine with a cement floor 3. ☐ Pit latrine with a slab/Sanplat 4. ☐ Fossa alterna 5. ☐ Skyloo/Urine Diverting Toilet 6. ☐ Lined pit latrine 7. ☐ Pour flush 8. ☐ Ventilated improved 9. ☐ Septic

	Technology Awareness and Choice
3.	What are the most important qualities in defining a good latrine?
4.	Which types of latrines are you aware of (*if necessary ask them to describe them)*? 1. ☐ Traditional latrine, mud floor 2. ☐ Pit latrine with a cement floor 3. ☐ Pit latrine with a slab/Sanplat 4. ☐ Fossa alterna 5. ☐ Skyloo/Urine Diverting Toilet 6. ☐ Lined pit latrine 7. ☐ Pour flush 8. ☐ Ventilated improved *9.* ☐ Septic
5.	Which have you seen and/or tried? Where? *Probe: you may list different latrines that have not been mentioned.*
6.	Of the types of latrines you know, which is your favourite? Why?
7.	What makes you like this latrine best?
8.	Which is your least favourite latrine? What do you dislike about this type of latrine?
9.	What things do you like the best about your current latrine?
10.	Why are these things important to you?
11.	Are there things about your current latrine that you dislike? Why?
12.	If you could make some improvements to your latrine, what improvements would you make? Why?

Motivations	
18.	Did you make the decision to build this type of latrine alone or were others involved in the decision? How?
19.	Who or what influenced your decision? In what way?
20.	In the end, what was the main reason you built ***this type* of latrine** not any other type?
21.	In your opinion, what are the real advantages you experience of having this type of latrine? Why/How?
22.	What about the advantages to other members of your household/plot? Why? *[elderly, women, children]*
23.	What about negative experiences, have you found any disadvantages or problems associated with having this type of latrine?

24.	Have other members of your household/plot had problems with this latrine? *[tenants elderly, children, women, disabled]*
25.	Do tenants use this latrine
26.	How have you attempted to overcome the problems you or other household members have experienced with this latrine?

Space for building new latrines	
27.	Did you have problems finding a spot/space where to build the current latrine? Why?
28.	How did you build your latrine in response to this problem?
29.	What did you do in response to this problem?
30.	What type of latrine will you build when this one fills up? Why?
31.	Do you have any concern about where you will build your next latrine when this one fills up? Why?
32.	How will you build your latrine in response to this problem?
33.	Do you have any fear that you may eventually run out of space for building latrines? Why?
34.	How do you intend to overcome this problem?
35.	*What causes this problem?*
	Modern toilets –
36.	Have you ever heard about or seen a ***urine diverting toilet? What about a fossa alterna (show pictures of these latrines and explain how they work, cost, advantages and disadvantages)***
37.	What do you think about a skyloo (urine diverting toilet)?
38.	Would you consider installing a skyloo? What about a fossa alterna? Why?
39.	What factors or circumstances would encourage you to install a urine diverting toilet?
40.	What factors or circumstances would discourage you from installing a urine diverting toilet
41.	Have you ever heard about or seen a pour flush latrine? ***Show a picture and explain costs, advantages, disadvantages***
42.	What do you think about pour flush latrines?
43.	*Would you consider installing a pour flush toilet?*
44.	What factors or circumstances would encourage you to install a pour flush latrine?
45.	What factors or circumstances would discourage you from installing a pour flush latrine?

Appendix 10: Focus group discussion guide used

Consent form

Hello, my name is _____and I am working with **WATERAID/WATER FOR PEOPLE** to support the development of a local sanitation industry that we hope will make it more desirable and easier for members of your community to invest in improved sanitation technologies.

Purpose of the research: I was hoping that you might have 2 hours to spare to talk about sanitation and access to alternative sanitation technologies particularly ecosan.

What you will do in this research: If you decide to take part in this interview, you will be asked several questions about the challenges people face when constructing new sanitation facilities, your thoughts about ecosan, the problem of space for constructing new sanitation facilities and how people address this problem.

Time required: The interview will take approximately 2 hours 30 minutes.

Benefits: This is a chance for you talk about alternative sanitation technologies and to tell your story about the process of acquiring a new sanitation facility, problems encountered and your opinions about alternative sanitation technologies particularly urine diverting toilets.

Confidentiality: Your responses to interview questions will be kept confidential. At no time will your names be revealed. You will be assigned a random numerical code. Anyone who will process the responses will only know you by this code. The questionnaire, without your names, will be kept for future references. The key code linking your name/s with your number will be kept in a locked file cabinet in a locked office, and no one else will have access to it. The data you will provide will be used in a research report and may be used as the basis for articles or presentations in the future. Your name or information that would identify you in any publications or presentations will not be used.

Participation and withdrawal: Taking part in this study is completely voluntary, and you may withdraw from the study at any time without penalty. You may withdraw by informing me that you no longer wish to participate (no questions will be asked). You may also skip any question during the interview, but continue to participate in the rest of the study.

Agreement:
The nature and purpose of this research have been sufficiently explained and we agree to take part in this study. We understand that we are free to withdraw at any time without incurring any penalty.

Date	
Name of respondent	
Gender of respondent	
Signature of respondent	
Location	

1.0 Latrine technologies

1.	What type of latrines do you promote?
2.	Which type do most people in this township prefer? Why?
3.	What materials do people usually use in building different parts of a latrine? Why
4.	Who makes decisions on the design of latrines?

2.0 Building problems

5.	What technical problems do people face when building latrines? e.g. Water table, rocks?
6.	What problems related to building materials do people face?
7.	How do they overcome these problems?

3.0 Problem of space for building latrines

8.	What do people mainly do when their latrines are full?
9.	Do you have people that empty latrines when they fill up?
10.	How do they empty the latrines?
11.	How much do they charge?
12.	Are there households that have limited space or are concerned about where to build a new latrine? What causes this problem?
13.	What do they do to respond to this problem? How do they build their latrines?
14.	Are their households that have no space at all for building latrines? What do they do about this problem?
15.	How many people have this problem?
16.	What do you advise landlords that have this problem?

4.0 Alternative technologies

17.	What alternative technologies do you promote?
18.	Do you think people want urine diverting toilets?
19.	What stops people from accepting urine diverting toilets?
20.	What are people generally saying about urine diverting toilets?
21.	Have you seen a urine diverting toilet that has been modified to make it more acceptable or suitable?
22.	How was the technology modified?

Appendix 11: Household survey questionnaire, Lilongwe city

Investigating sanitation technology choices & factors affecting the adoption of urine diverting toilets

Consent form

Hello, my name is _____and I am working with **WATERAID/WATER FOR PEOPLE** to support the development of a local sanitation industry that we hope will make it more desirable and easier for members of your community to invest in improved sanitation technologies. Are you the home owner at this compound? *[If no, ask to speak to the home owner]*

Purpose of the research: I was hoping that you might have 2 hours to spare to share with me your sanitation technology choices and what you think about ecosan and other alternative sanitation technologies. Hopefully then we can learn from your experiences and opinions to help encourage higher sanitation coverage in this area.

What you will do in this research: If you decide to take part in this interview, you will be asked several questions about your latrine, ecosan and other alternative sanitation technologies.

Time required: The interview will take approximately 2 hours.

Benefits: This is a chance for you know more about alternative sanitation technologies and to tell your story about the process of acquiring a sanitation facility, problems encountered and your opinions about alternative sanitation technologies.

Confidentiality: Your responses to interview questions will be kept confidential. At no time will your actual identity be revealed. You will be assigned a random numerical code. Anyone who will process the responses will only know you by this code. The questionnaire, without your name, will be kept for future references. The key code linking your name/s with your number will be kept in a locked file cabinet in a locked office, and no one else will have access to it. The data you will provide will be used in a research report and may be used as the basis for articles or presentations in the future. Your name/s or information that would identify you in any publications or presentations will not be used.

Participation and withdrawal: Taking part in this study is completely voluntary, and you may withdraw from the study at any time without penalty. You may withdraw by informing me that you no longer wish to participate (no questions will be asked). You may also skip any question during the interview, but continue to participate in the rest of the study.

Agreement:
The nature and purpose of this research have been sufficiently explained and I agree to take part in this study. I understand that I am free to withdraw at any time without incurring any penalty.

Date	
Name of respondent	
Gender of respondent	
Signature of respondent	
Location	

PART 1

	Type of current and previous sanitation facility
1.	What type of sanitation facility do you have now?
	1. ☐Pit latrine slab/cement floor 2. ☐Pit latrine with a mud floor 3. ☐Ventilated improved pit latrine 4. ☐Lined pit latrine 5. ☐Pour flush latrine ***6.*** ☐**Urine diverting toilet (UDT)** *7.* ☐**Fossa alterna –** 8. ☐Septic tank 9. ☐No latrine 10. ☐Other: specify_____
2.	What type of sanitation facility did you have before you built this current latrine
	1. ☐Pit latrine slab/cement floor 2. ☐Pit latrine with a mud floor 3. ☐Ventilated improved pit latrine 4. ☐Lined pit latrine 5. ☐Pour flush latrine **6.** ☐**Urine diverting toilet (UDT)** *7.* ☐**Fossa alterna** 8. ☐Septic tank 9. ☐No latrine 10. ☐This is the first latrine 11. ☐Other: specify_____
	The construction process
3.	Who constructed your current sanitation facility?
	1. ☐ home owner himself/herself *2.* ☐Tenant/s 3. ☐Builder hired by home owner 4. ☐Partly by mason part by home owner.
4.	If a builder was hired; How did you find the builder/mason?
	1. ☐Through my relative/friend 2. ☐He is my neighbour 3. ☐Through a friend of mine 4. ☐ I have hired him before *5.* ☐A hygiene promoter linked me 6. ☐Neighbour recommended him to me 7. ☐NGO identified him for me 8. ☐Identified him from a catalogue, 9. ☐N/a – toilet built by home owner 10. ☐There is no toilet
5.	Was this latrine built on a new spot or on a spot where there was a latrine before?
	1. ☐On a new spot (never used before) 2. ☐There was a latrine on this spot *3.* ☐On an old rubbish pit 4. ☐On a bathroom spot 5. ☐I pulled a house/room down 6. ☐I do not know 7. ☐Other-specify----------

PART 2

6.	How much did you spend on your current latrine?
	Digging pit _____ Building- Labour _____ Bricks/blocks_____ Cement_____ Sand_____ Support worker _____ Roofing_____ Door _____ Slab/logs_____ Metal for the floor_____ Quarry_____ Other costs____ Total cost (MK) _____
7.	Did you get a loan to construct the latrine? 1. ☐Yes 2.☐No
8.	***If yes,*** How much was the loan (MK) _____
	Where did you get this loan?
	1. ☐New Building society 2. ☐Opportunity Bank 3. ☐Federation/CCODE 4. ☐Habitat for humanity 5. ☐Women's savings group 6. ☐Money lenders 7. ☐From a friend 8. ☐From a relative 9. ☐N/A – did not get a loan
	Concern about Space for new sanitation facilities
9.	How concerned were you about space for sanitation when you were building this current latrine? 1☐Not concerned 2☐Little bit concerned 4☐Concerned 5☐Very concerned
10.	How concerned are you about space for sanitation right now? 1☐Not concerned 2☐Little bit concerned 4☐Concerned 5☐Very concerned
11.	If there is a concern about space ASK? Why are you concerned about space for sanitation?
A	*There are many houses on my plot –* 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
B	*I did not reserve enough space for sanitation* 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
C	*I build toilets regularly –* 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
D	*I bought a small plot –* 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
E	*I have built toilets on all the available spaces* 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
F	*I have dug refuse/rubbish pits on all the space available–* 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree

PART 3

	Availability of space on the plot for sanitation
12.	When did you start living on this plot? Year [ ]
13.	Do you have a refuse pit on your plot? 1. ☐Yes 2. ☐No
14.	If no, why not - 1☐There is no space 2.☐ I use a bin/bag 3.☐Other reason:……
15.	Do you have a backyard maize/vegetable garden? 1☐Yes 2.☐No
16.	Do you have vacant space on your plot where you could build another house if you wanted to? 1. ☐Yes 2.☐No
17.	Do you have space next to your house where you could extend your house if you wanted to? 1. ☐Yes 2.☐No
18.	If yes, What is mainly stopping you from building another house on that space?
	1. ☐Reserving it for new toilets 3. ☐I kept it for other uses:…… 2. ☐No capital right now 4. ☐Other:……
	Environmental concern
19.	Digging a pit for a toilet on this plot is difficult because of high water table 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
20.	Digging a pit for a toilet on this plot is difficult because of shallow bedrock 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
21.	Digging a pit for a toilet is difficult because the soil on this plot is sandy 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
22.	**Number of people at the plot & toilet use**
23.	Are there tenants on the plot? 1☐ Yes 2☐No
24.	How many households (including the landlord's) live on this plot?_____ households
25.	How many people live on this plot? _____people
26.	How many latrines are there on this plot? _____latrines
27.	Do tenants use the same toilet you use? 1☐Yes 2☐No

PART 4

	Customer satisfaction with current sanitation facility
28.	How satisfied are you with your current latrine? 1☐Very dissatisfied 2☐Dissatisfied 3☐Neither 4☐Satisfied 5☐Very satisfied
29.	If dissatisfied - ASK What are the reasons why you are very dissatisfied or somewhat dissatisfied? Tick reasons given identified by respondent don't read out
	1. ☐Poorly built 2. ☐It is shallow 3. ☐it is not lined 4. ☐It may collapse 5. ☐I do not get compost 6. ☐Too many users 7. ☐It is smelly 8. ☐I can see the faeces 9. ☐Because of flies **10.** ☐Expensive to empty 11. ☐Difficult to empty 12. ☐Adding ash & soil is involving 13. ☐It has no roof 14. ☐It has no door 15. ☐No plastered 16. ☐There is no slab or cement floor 17. ☐Difficult to clean 18. ☐No privacy 19. ☐It is not smart/clean 20. ☐Other reason:_____ 21. ☐N/a – satisfied with current toilet
	Pit emptying history
30.	Has the current latrine ever been emptied in any way? 1. ☐Yes - 2.☐No -
31.	If yes, what motivated you to empty your toilet?
A	*I did not have space to build a new latrine –* 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
B	*I was tired of building again and again –* 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
C	*My toilet was designed to be emptied –* 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
D	*My toilet was too good to pull it down* 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
E	*It was cheaper to empty than to build again –* 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
F	*I wanted to save space* 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
32.	How many times has the facility been emptied? _____times

PART 4 CONTINUED

Who emptied the latrine last time it was emptied and how was it emptied? ☐Myself 2. ☐Private company with a vacuum tanker	
1. ☐Gulper 2. ☐Buckets 3. ☐Shovels, hoes *4.* ☐Vacuum tanker	5. ☐Dug another pit next to the toilet and disludged 6. ☐Chemicals: 7. ☐Other-specify_____
How satisfied were you with the emptying service?	
1. ☐Very satisfied 2. ☐Satisfied *3.* ☐Neither satisfied or dissatisfied	4. ☐Dissatisfied 5. ☐Very dissatisfied 6. ☐Latrine has never been emptied
If dissatisfied or very dissatisfied ASK: Why do you feel this way?	
1. ☐Not all the toilet was emptied 2. ☐It was expensive *3.* ☐I used a lot of water	4. ☐Other_____ 5. ☐Toilet filled up again after a short time

PART 5 -

	Knowledge and awareness about alternative technologies		
33.	Have you ever heard about or seen the following sanitation technologies? Show pictures and explain technologies- advantages and disadvantages and cost.		
	Have you ever seen or heard about a pour flush toilet?	Have you ever seen or heard about a urine diverting toilet/skyloo	Have you ever seen or heard about a fossa alterna toilet?
	1.☐ N***ever*** heard or seen it 2.☐Have only heard about it 3.☐ Have heard & seen it Source:_____	1.☐ N***ever*** heard or seen it 2.☐Have only heard about it 3.☐ Have heard & seen it Source:_____	1.☐ N***ever*** heard or seen it 2.☐Have only heard about it 3.☐ Have heard & seen it Source:_____
	Main source of information		
	1. ☐Through my neighbour/friend 2. ☐Through a hygiene promoter 3. ☐Through a mason/builder 4. ☐Through a relative 5. ☐catalogue/brochure ***6.*** ☐At the demonstration centre	7. ☐At a public meeting 8. ☐From NGO staff 9. ☐From the radio 10. ☐From the TV *11.* ☐Other_____ ***12.*** ☐N/A – Never heard or seen	
	MOTIVATING FACTORS		
34.	What could motivate you or encourage you to build a urine diverting toilet?		
A	Access to compost would motivate me to adopt UDT 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree		

PART 5 CONTINUED

B	I would be motivated to adopt because it is permanent 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
C	I would be motivated to adopt because it does not smell 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
D	I would be motivated to adopt because it would make me look modern 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
E	I would be motivated to adopt because it will not collapse 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
F	I would be motivated to adopt because it safer for children to use 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
G	I would be motivated to adopt because it is cheaper to empty 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
35.	**BARRIERS ASSOCIATED WITH URINE DIVERTING TOILETS**
A	The shallow depth would stop me from adopting– 1☐Strongly disagree 2☐Disagree 3☐ Agree 4☐Strongly agree
B	The task of adding ash and soil would stop me from adopting UDT 1☐Strongly disagree 2☐Disagree 3☐ Agree 4☐Strongly agree
C	The task of emptying compost from the toilet would stop me from adopting UDT 1☐Strongly disagree 2☐Disagree 3☐ Agree 4☐Strongly agree
D	Lack of maize/vegetable garden would stop me from adopting UDT 1☐Strongly disagree 2☐Disagree 3☐ Agree 4☐Strongly agree
E	The installation cost would stop me from adopting UDT 1☐Strongly disagree 2☐Disagree 3☐ Agree 4☐Strongly agree
F	The number of people on my plot would stop me from adopting UDT 1☐Strongly disagree 2☐Disagree 3☐ Agree 4☐Strongly agree

PART 5 CONTINUED

	ATTITUDE TOWARDS URINE DIVERTING TOILET
A	With the number of people on my plot; a UDT is feasible 1☐Strongly disagree 2☐Disagree 3 ☐ Agree 4☐Strongly agree
B	With the space I have, a UDT would be better 1☐Strongly disagree 2☐Disagree 3 ☐ Agree 4☐Strongly agree
C	Handling compost from human excreta is disgusting 1☐Strongly disagree 2☐Disagree 3 ☐ Agree 4☐Strongly agree
D	The task of adding ash and soil is too involving 1☐Strongly disagree 2☐Disagree 3 ☐ Agree 4☐Strongly agree
E	The task of collecting ash and soil is too involving 1☐Strongly disagree 2☐Disagree 3 ☐ Agree 4☐Strongly agree
F	Emptying a Urine diverting toilet is too involving 1☐Strongly disagree 2☐Disagree 3 ☐ Agree 4☐Strongly agree
G	I can afford to install a Urine diverting toilet 1☐Strongly disagree 2☐Disagree 3 ☐ Agree 4☐Strongly agree
H	Finding a builder to build a Urine diverting toilet would not be a problem – 1☐Strongly disagree 2☐Disagree 3 ☐ Agree 4☐Strongly agree
I	People that are important to me say that I should adopt a Urine diverting toilet 1☐Strongly disagree 2☐Disagree 3 ☐ Agree 4☐Strongly agree
J	Hygiene promoters say that I should adopt a Urine diverting toilet 1☐Strongly disagree 2☐Disagree 3 ☐ Agree 4☐Strongly agree
K	Builders say that I should adopt a Urine diverting toilet 1☐Strongly disagree 2☐Disagree 3 ☐ Agree 4☐Strongly agree

PART 6

INTENTION OF PROPERTY OWNER	
36.	How full is your toilet now? 1☐Not yet full 3☐Nearly full 4☐full, we are about to build another
37.	How soon do you expect to build another toilet? 1☐Within the next 6 months 2☐From 7-12 months 3☐Over 12 months
38.	***Explain:*** When your latrine fills up, you will have three options: (1) Building another toilet similar to the one you have, (2) Building one of the three alternative technologies we have talked about or any technology of your choice or, (3) emptying your current sanitation facility.
39.	When your latrine eventually fills up, what would do if emptying would cost you MK20, 000?
40.	1.☐ Empty current latrine 2.☐I will pull it down and build another toilet –
41.	***If property owner intends to empty current sanitation facility – ASK***
42.	What would motivate you to empty your toilet?
A	I do not have space to build a new latrine – 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
B	I have limited space for sanitation – 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
C	I am tired of building toilets again and again- 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
D	Toilet was designed to be emptied – 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
E	The quality of my toilet is too good to pull it down – 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
F	It's cheaper to empty than to build again – 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
G	I want to save space – 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
H	I do not want to build a toilet on an old toilet spot – 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree

PART 6 CONTINUED

If property owner intends to build another toilet –ASK	
Where will you build your new toilet?	
1. ☐New spot, behind the house 2. ☐New spot, front of house *3.* ☐On a bathroom spot	4. ☐Will pull down one house 5. ☐On an old latrine spot ***6.*** ☐On previous refuse pit spot ***7.*** ☐I do not know (explain)_____
TECHNOLOGY CHOICES	
We have talked about fossa alterna, urine diverting toilets (skyloos) and pour flush toilets. We have also talked about pit emptying. When your latrine fills up, what option will you choose if emptying would cost you MK20, 000? ***Read out the options:***	
1. ☐Pit latrine slab/cement floor 2. ☐Pit latrine with a mud floor 3. ☐Lined pit latrine 4. ☐Pour flush latrine 5. ☐*Urine diverting/(skyloo)*	6. ☐Fossa alterna 7. ☐Septic tank 8. ☐No latrine 9. ☐Empty the toilet 10. ☐Other: specify_____
Why would you choose this option?	
1. ☐It's what I can afford 2. ☐Easy to construct 3. ☐Deep, takes time to fill 4. ☐Many people can use 5. ☐It is permanent, 6. ☐ It will not collapse 7. ☐There is no space ***8.*** ☐To access compost	9. ☐Does not smell 10. ☐Easy to use 11. ☐Easy to empty 12. ☐Cheap to empty 13. ☐My image will 14. ☐I will lock modern 15. ☐It's what I am used ***16.*** ☐Other-specify_____

PART 6 CONTINUED

	MICROFINANCE FOR SANITATION		
	Now imagine that there is an opportunity for a loan for you to build a toilet of your choice. If the amount offered to be taken as loan ranged from MK10, 000 to MK100, 000. The loan is to be paid back within 1 year at an interest of 2% which is charged on your loan balance every month. You can pay back this loan within a year or 2 years.		
43.	Would you be interested to take this loan? 1. ☐Yes 2.☐No		
44.	If yes, how much would you be willing to take? *MK* [ ]		
45.	What payment period would you choose? 1.☐ 12 months 2.☐24 months		
46.	Out of the types of latrines we have talked about (mention all the options), what type of sanitation would you install if you took a loan?		
	1. ☐Pit latrine slab floor 2. ☐Pit latrine with mud floor 3. ☐lined pit latrine	4. ☐Pour flush 5. ☐*Urine diverting* 6. ☐Fossa alterna	7. ☐Septic tank 8. ☐No latrine 9. ☐Empty the toilet 10. ☐Other: specify……

PART 7 - ADOPTERS

1.	What motivated you to build urine diverting toilet/skyloo or fossa alterna?
A	To access compost- 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
B	You were building toilets regularly 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
C	To avoid problem of lack of space for sanitation 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
D	To reduce flies- *1*☐*Strongly disagree* *2*☐*Disagree* *3*☐*Agree* *4*☐*Strongly agree*
E	To look modern – *1*☐*Strongly disagree* *2*☐*Disagree* *3*☐*Agree* *4*☐*Strongly agree*
F	To avoid risk of toilet collapsing when it rains – *1*☐*Strongly disagree* *2*☐*Disagree* *3*☐*Agree* *4*☐*Strongly agree*
G	To avoid risks of children/people falling into toilets- *1*☐*Strongly disagree* *2*☐*Disagree* *3*☐*Agree* *4*☐*Strongly agree*

PART 7 CONTINUED

2.	Do tenants use the ecosan toilet? 1. ☐Yes 2.☐No 3.☐ Sometimes they use	
3.	If no, ASK - Why don't tenants use the ecosan toilet?	
	☐It will fill up within a short time ☐They say it's too involving	☐They can't manage to use it properly ☐I built it for me and my family only

4.	Last time you emptied, how many months did you wait before emptying a chamber? [ ] months	
5.	How many months does an ecosan chamber take to fill? .[ ] months	
6.	What materials do you add into the chambers after defecating?	
	1. ☐Ash & soil in different buckets 2. ☐Soil and ash mixed together	3. ☐Ash only 4. ☐Soil only 5. ☐Other_____
7.	What do you do with the compost	
	1. ☐Used in my maize/vegetable garden 2. ☐Used in my flower garden 3. ☐Gave the compost to someone 4. ☐Sold compost	5. ☐Other:…… 6. ☐Just threw away the compost 7. ☐Kept the compost in bags

PART 8

Marital status	Education	Man source of income?	Religion	Age	Household Monthly income	
1. ☐Married. 2.☐Single *Gender* 1.☐Male 2.☐Female	1.☐None 2.☐Primary 3.☐Secondary 4.☐College	1.☐Formal work 2.☐Informal work 3.☐Trade 4.☐House rental fees 5.☐Children support	1.☐Moslem 2.☐Christian 3.☐None	1.☐<15 2.☐15-24 3.☐25-34 4.☐35-49 5.☐50-64 6.☐> 65	1.☐<10,000 2.☐11- 20,000 3.☐21-30,000 4.☐31-40,000 5.☐41-50,000	6.☐51-60,000 7.☐61,-70,000 8.☐71- 80,000 9.☐>80,000

Radio?	Own a phone	Own a TV	Own maize garden in the city	Is there a refuse pit
1.☐Yes 2.☐No	1.☐Yes 2.☐NO	1.☐Yes 2.☐No	1.☐Yes, my own garden 2.☐No 3.☐Yes, rented garden	1.☐Yes 2.☐No

PART 8 CONTINUED

Telephone number:

If there are other questions that you are not able to answer I will be able to ask your spouse but also to find out whether you will be successful to build the facility you have selected.

Latrine observations

Roof	Superstructure	Door	Bathroom water into toilet	Hand wash facility	Soap for hand wash
1.☐Thatched 2.☐Iron sheets 3.☐Tiles 4.☐Tin roof 5.☐Plastic 6.☐No roof	1.☐Burnt brick 2.☐Mud brick 3.☐wood 4.☐Mud house 5.☐Grass 6.☐Reeds	1.☐Wooden 2.☐paper 3 ☐cloth 4.☐No door	1.☐Yes 2,☐No	1.☐Yes 2,☐No	1.☐Yes 2,☐No

Housing conditions

Roofing	Wall	Floor	Water Source	Electricity
1.☐Thatched 2.☐Iron sheets 3.☐Tiles 4.☐Tin roof 5.☐Plastic	1.☐Burnt brick 2.☐Mud brick 3.☐wood/Plank 4.☐Mud house 5.☐Grass 6.☐Reeds/straw	1.☐Cement 2.☐Mud 3.☐Tiles	1.☐Water kiosk 2.☐piped into yard 3.☐Piped into house 4.☐public tap 5.☐Borehole 6.☐Well	1.☐Yes 2.☐No

Location of house surveyed

Easting								***Northing***							

Closing remarks:

Thank you very much for your time and answers. Do you have any questions that you want to ask me? I will come again in the near future to see your new toilet.

Comments: (any comments about the interview itself, the person being interviewed)

_____

Appendix 12: Household survey questionnaire, Blantyre City

Consent form

Hello, my name is _____and I am working with **WATER FOR PEOPLE** to support the development of a local sanitation industry that we hope will make it more desirable and easier for members of your community to invest in improved sanitation technologies. Are you the home owner at this compound? *[If no, ask to speak to the home owner]*

Purpose of the research: I was hoping that you might have 2 hours to spare to share with me your sanitation technology choices and what you think about ecosan and other alternative sanitation technologies. Hopefully then we can learn from your experiences and opinions to help encourage higher sanitation coverage in this area.

What you will do in this research: If you decide to take part in this interview, you will be asked several questions about your latrine, ecosan and other alternative sanitation technologies.

Time required: The interview will take approximately 2 hours.

Benefits: This is a chance for you know more about alternative sanitation technologies and to tell your story about the process of acquiring a sanitation facility, problems encountered and your opinions about alternative sanitation technologies.

Confidentiality: Your responses to interview questions will be kept confidential. At no time will your actual identity be revealed. You will be assigned a random numerical code. Anyone who will process the responses will only know you by this code. The questionnaire, without your name, will be kept for future references. The key code linking your name/s with your number will be kept in a locked file cabinet in a locked office, and no one else will have access to it. The data you will provide will be used in a research report and may be used as the basis for articles or presentations in the future. Your name/s or information that would identify you in any publications or presentations will not be used.

Participation and withdrawal: Taking part in this study is completely voluntary, and you may withdraw from the study at any time without penalty. You may withdraw by informing me that you no longer wish to participate (no questions will be asked). You may also skip any question during the interview, but continue to participate in the rest of the study.

Agreement:

The nature and purpose of this research have been sufficiently explained and I agree to take part in this study. I understand that I am free to withdraw at any time without incurring any penalty.

Date	
Name of respondent	
Gender of respondent	
Signature of respondent	
Location	

PART 1

	Type of current and previous sanitation facility
1.	What type of latrine do you have now?
	1. ☐Pit latrine slab/cement floor 2. ☐Pit latrine with a mud floor 3. ☐Ventilated improved pit latrine 4. ☐Lined pit latrine 5. ☐Pour flush latrine ***6.*** ☐**Urine diverting toilet (UDT)** *7.* ☐**Fossa alterna –** 8. ☐Pit latrine with a slab/cement & UDT 9. ☐Septic tank 10. ☐No latrine 11. ☐Other: specify_____
2.	What type of latrine did you have before you built this current latrine
	1. ☐Pit latrine slab/cement floor 2. ☐Pit latrine with a mud floor 3. ☐Ventilated improved pit latrine 4. ☐Lined pit latrine 5. ☐Pour flush latrine **6.** ☐**Urine diverting toilet (UDT)** *7.* ☐**Fossa alterna** 8. ☐Pit latrine with a slab/cement & UDT 9. ☐No latrine 10. ☐This is the first latrine 11. ☐Other: specify_____
5.	Who constructed your current latrine?
	1. ☐Myself/homeowner *2.* ☐Tenants 3. ☐Mason/builder hired by home owner 4. ☐Partly by mason, partly by home owner.
6.	If a mason was hired; How did you find the builder/mason?
	1. ☐Through my relative/friend 2. ☐He is my neighbour 3. ☐Through a friend of mine 4. ☐ I have hired him before *5.* ☐Through a hygiene promoter 6. ☐Neighbour recommended him to me 7. ☐NGO identified him for me 8. ☐Identified him from a catalogue 9. ☐N/a – toilet built by home owner 10. ☐There is no toilet
7.	Was this latrine built on a new spot or on a spot where there was a latrine before?
	1. ☐On a new spot (never used before) 2. ☐There was a latrine on this spot *3.* ☐On an old rubbish pit 4. ☐On a bathroom spot 5. ☐I pulled a house/room down 6. ☐I do not know 7. ☐Other-specify----------
8.	How much did you spend on your current latrine?
9.	Did you get a loan to construct the latrine? 1. ☐Yes 2.☐No
10.	***If yes,*** How much was the loan (MK) _____
	Where did you get this loan?
	10. ☐New Building society 11. ☐Opportunity Bank 12. ☐Federation/CCODE 13. ☐Habitat for humanity 14. ☐Women's savings group 15. ☐Money lenders 16. ☐From a friend 17. ☐From a relative 18. ☐N/A – did not get a loan

PART 2

	Concern about Space for new sanitation facilities
11.	How concerned are you about space for sanitation 1☐Not concerned 2☐Little bit concerned 4☐concerned 5☐Very concerned
12.	If there is a concern about space ASK? Why are you concerned about space?
A	*I bought a small plot* 1☐strongly disagree, 2☐disagree 3☐Agree 4☐strongly agree
B	*There are many houses on my plot –* 1☐strongly disagree, 2☐disagree 3☐Agree 4☐strongly agree
C	*I have built toilets on all the available spaces* 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
	Availability of space on the plot for sanitation
13.	When did you start living on this plot? Year [ ]
14.	Do you have a refuse pit on your plot? 1. ☐Yes 2. ☐No
15.	***If no, why not -*** 1☐There is no space 2.☐ I use a bin/bag 3.☐Other reason:……
16.	Do you have a backyard maize/vegetable garden? 1☐Yes 2.☐No
17.	Do you have vacant space on your plot where you could build another house if you wanted to? 1. ☐Yes 2.☐No
18.	Do you have space next to your house where you could extend your house if you wanted to? 1. ☐Yes 2.☐No
19.	If yes, What is mainly stopping you from building another house on that space?
	1. ☐Reserving it for new toilets 2. ☐No capital right now 3. ☐I kept it for other uses:…… 4. ☐Other:……
	Frequency of building new pit latrines
20.	Have you ever had a toilet that collapsed? 1. ☐Yes 2.☐No
21.	How do you plan to reduce the risk of collapsing of pit latrines? (1) (2) (3)
22.	What may stop you from implementing your plans? (1) (2) (3)

PART 2 CONTINUED

	Environmental concern
23.	Is digging a pit for a toilet on this plot difficult because you find water easily – high water table? 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
24.	Is digging a pit for a toilet on this plot difficult because of rocks on this plot? 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
25.	Is digging a pit for a toilet difficult because the soil on this plot is sandy? 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
26.	**Number of people at the plot & toilet use**
27.	Are there tenants on the plot? 1☐ Yes 2☐No
28.	How many households (including the landlord's) live on this plot? _____
29.	How many people live on this plot? _____people
30.	How many latrines are there on this plot? _____latrines
31.	Do tenants use the same toilet you use? 1☐Yes 2☐No
	Customer satisfaction with current sanitation facility
32.	How satisfied are you with your current latrine? 1☐Very dissatisfied 2☐Dissatisfied 3☐Neither 4☐Satisfied 5☐Very satisfied
33.	If dissatisfied - ASK What are the reasons why you are very dissatisfied or somewhat dissatisfied? ***Tick reasons given identified by respondent don't read out***
	1. ☐Poorly built 2. ☐It is shallow 3. ☐it is not lined 4. ☐It may collapse 5. ☐I do not get compost from it 6. ☐Too many users –fills quickly 7. ☐It is smelly 8. ☐I can see the faeces 9. ☐Because of flies **10.** ☐Expensive to empty 11. ☐Difficult to empty 12. ☐Adding ash and soil is too involving 13. ☐It has no roof 14. ☐It has no door 15. ☐No plastered 16. ☐There is no slab or cement floor 17. ☐Difficult to clean 18. ☐No privacy 19. ☐It is not smart/clean 20. ☐Other reason:_____ 21. ☐N/a – satisfied with current toilet

PART 3

	Pit emptying history –	
34.	Has the current latrine ever been emptied in any way? 1. ☐Yes - 2.☐No -	
35.	If yes, what motivated you to empty your toilet?	
36.	How many times has the facility been emptied? _____times	
37.	Who emptied the latrine last time it was emptied and how was it emptied? ☐Myself 2. ☐Contractor	
	1. ☐Gulper/ hand pump 2. ☐Buckets and scoops 3. ☐Shovels, hoes, bags *4.* ☐Vacuum tanker	5. ☐Dug another pit next to the toilet and disludged manually 6. ☐Chemicals: 7. ☐Other-specify_____
38.	How satisfied were you with the emptying service?	
	7. ☐Very satisfied 8. ☐Satisfied *9.* ☐Neither satisfied or dissatisfied	10. ☐Dissatisfied 11. ☐Very dissatisfied 12. ☐N/A Latrine has never been emptied
39.	If dissatisfied or very dissatisfied ASK: Why do you feel this way?	
	1. ☐Not all the toilet was emptied 2. ☐It was expensive *3.* ☐I used a lot of water	4. ☐Other_____ 5. ☐Toilet filled up again after a short time 6.
	Knowledge and awareness about alternative technologies	
40.	Have you ever heard about or seen the following sanitation technologies? Show pictures and explain technologies- advantages and disadvantages and cost.	
	Have you ever seen or heard about a pour flush toilet?	Have you ever seen or heard about a urine diverting toilet/skyloo Have you ever seen or heard about a fossa alterna toilet?
	1.☐ N***ever*** heard or seen it 2.☐Have only heard about it 3.☐ Have heard & seen it Source:_____	1.☐ N***ever*** heard or seen it 2.☐Have heard about it 3.☐ Have heard & seen it Source:_____
	Main source of information	
	1. ☐Through my neighbour/friend 2. ☐Through a hygiene promoter 3. ☐Through a mason/builder 4. ☐Through a relative 5. ☐I saw these in catalogue/brochure ***6.*** ☐At the demonstration centre	7. ☐At a public meeting 8. ☐From NGO staff 9. ☐From the radio 10. ☐From the TV *11.* ☐Other_____ ***12.*** ☐N/A – Never heard or seen the technology.

PART 3 CONTINUED

	POSITIVE ATTRIBUTES/MOTIVATION
41.	What could motivate you or encourage you to build a urine diverting toilet?
A	Access to compost would motivate me to adopt urine diverting toilet 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
B	I would be motivated to adopt because it is permanent 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
C	I would be motivated to adopt because it does not smell 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
D	I would be motivated to adopt because it would make me look modern 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
E	I would be motivated to adopt because it will not collapse 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
F	I would be motivated to adopt because it is safer for children- 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
G	I would be motivated to adopt because it is cheaper to empty – 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
42.	**NEGATIVE ATTRIBUTES/BARRIERS**
A	The shallow depth would stop me from adopting UDT– *1☐Strongly disagree 2☐Disagree 3☐ Agree 4☐Strongly agree*
B	The task of adding ash would stop me from adopting UDT *1☐Strongly disagree 2☐Disagree 3☐ Agree 4☐Strongly agree*
C	The task of adding soil would stop me from adopting UDT *1☐Strongly disagree 2☐Disagree 3☐ Agree 4☐Strongly agree*
D	The task of emptying UDT would stop me from adopting *1☐Strongly disagree 2☐Disagree 3☐ Agree 4☐Strongly agree*
E	Lack of maize/vegetable garden would stop me from adopting UDT *1☐Strongly disagree 2☐Disagree 3☐ Agree 4☐Strongly agree*
F	The installation cost would me from adopting UDT *1☐Strongly disagree 2☐Disagree 3☐ Agree 4☐Strongly agree*
G	The number of people on my plot would stop me from adopting UDT *1☐Strongly disagree 2☐Disagree 3☐ Agree 4☐Strongly agree*
H	Handling compost from human excreta is disgusting *1☐Strongly disagree 2☐Disagree 3☐ Agree 4☐Strongly agree 4*

	INTENTION OF PROPERTY OWNER
44.	How full is your toilet now? 1☐Not yet full 3☐Nearly full 4☐full, we are about to build another
45.	How soon do you expect to build another toilet? 1☐Within the next 6 months 2☐From 7-12 months 3☐Over 12 months
46.	***Explain the following:*** When your latrine fills up, you will have three options: (1) Building another toilet similar to the one you have, (2) Building one of the three alternative technologies we have talked about or any technology of your choice or, (3) emptying your current sanitation facility.
47.	What would you do if emptying would cost you MK10, 000?
48.	When your latrine eventually fills up, what would you do if emptying would cost you MK20, 0000? 1.☐I expect to empty it 2. ☐I will pull it down and build another sanitation facility.
49.	**If property owner intends to empty current sanitation facility at MK20,000 - ASK**
50.	What would motivate you to empty your toilet?
A	I do not have space to build a new latrine – 1☐strongly disagree 2☐disagree 3☐Agree 4☐strongly agree
C	I do not want to build another facility- 1☐strongly disagree, 2☐disagree 3☐Agree 4☐strongly agree
D	The toilet was designed to be emptied – 1☐strongly disagree, 2☐disagree 3☐Agree 4☐strongly agree
E	My toilet is too good to pull it down – 1☐strongly disagree, 2☐disagree 3☐Agree 4☐strongly agree
F	It's cheaper to empty than to build again – 1☐strongly disagree, 2☐disagree 3☐Agree 4☐strongly agree
G	You want to save space – 1☐strongly disagree, 2☐disagree 3☐Agree 4☐strongly agree
H	You do not want to build a toilet on an old toilet spot – 1☐strongly disagree, 2☐disagree 3☐Agree 4☐strongly agree

	If property owner intends to build another toilet –ASK	
51.	Where will you build your new toilet?	
	1. ☐New spot, behind the house 2. ☐New spot at the front *3.* ☐On a bathroom spot	4. ☐Will pull down one house 5. ☐On an old latrine spot ***6.*** ☐On previous refuse pit spot ***7.*** ☐I do not know (explain)_____
	TECHNOLOGY CHOICES	
52.	We have talked about fossa alterna, Urine diverting toilets and pour flush toilets. We have also talked about pit emptying. When your latrine fills up, you could install one of the technologies we have talked about, empty your facility or any other technology of your choice. What option will you choose if emptying would cost you MK20, 000? ***Read out the following options:***	
	1. ☐Pit latrine slab/cement floor 2. ☐Pit latrine with a mud floor 3. ☐lined pit latrine 4. ☐Pour flush latrine 5. ☐*Urine diverting/(skyloo)*	6. ☐Fossa alterna 7. ☐Septic tank 8. ☐No latrine 9. ☐Empty the toilet 10. ☐Other: specify_____
	Why would you choose this option?	
	1. ☐It's what I can afford 2. ☐Easy to construct 3. ☐Deep, takes time to fill 4. ☐Many people can use 5. ☐It is permanent, 6. ☐ It will not collapse 7. ☐There is no space ***8.*** ☐To access compost	9. ☐Does not smell 10. ☐Easy to use 11. ☐Easy to empty 12. ☐Cheap to empty 13. ☐My image will improve 14. ☐I will lock modern 15. ☐It's what I am used ***16.*** ☐Other-specify_____

	MICROFINANCE FOR SANITATION		
	Now imagine that there is an opportunity for a loan for you to build a toilet of your choice. If the amount offered to be taken as loan ranged from MK10, 000 to MK100, 000. The loan is to be paid back within 1 year or 2 years at an interest of 2% which will be charged on your loan balance every month.		
53.	Would you be interested to take this loan? 1. ☐Yes 2.☐No		
54.	If yes, how much would you be willing to take? *MK* [ ]		
55.	What payment period would you choose? 1.☐ 12 months 2.☐24 months		
56.	What type of sanitation would you install if you took a loan?		
	1. ☐Pit latrine cement floor 2. ☐Pit latrine mud floor 3. ☐lined pit latrine	4. ☐Pour flush 5. ☐*UDT* 6. ☐Fossa alterna	7. ☐Septic tank 8. ☐No latrine 9. ☐Other: specify…

UDT ADOPTER

1.	What motivated you to build urine diverting toilet/skyloo or fossa alterna?
A	To access compost- 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
B	I was building toilets regularly 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
C	To avoid problem of lack of space for sanitation 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
D	To reduce flies- 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
E	To look modern – 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
F	To avoid risk of toilet collapsing when it rains – 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree
G	To avoid risks of children/people falling into toilets- 1☐Strongly disagree 2☐Disagree 3☐Agree 4☐Strongly agree

2.	Do tenants use the ecosan toilet? 1. ☐Yes 2.☐No 3.☐ Sometimes they use	
3.	If no, ASK - Why don't tenants use the ecosan toilet?	
	☐It will fill up within a short time ☐They say it's too involving	☐They can't manage to use it properly ☐I built it for me and my family only

4.	Last time you emptied, how many months did you wait before emptying a chamber? [ ] months	
5.	How many months does an ecosan chamber take to fill? .[ ] months	
6.	What materials do you add into the chambers after defecating?	
	1. ☐Ash & soil kept in different buckets 2. ☐Soil and ash mixed together	3. ☐Ash only 4. ☐Soil only 5. ☐Other_____
7.	What do you do with the compost	
	8. ☐Used in my maize/vegetable garden 9. ☐Used in my flower garden 10. ☐Gave the compost to someone 11. ☐Sold compost	12. ☐Other:…… 13. ☐Just threw away the compost 14. ☐Kept the compost in bags

Socio economic, demographic information

Marital status	Education	Man source of income?	Religion	Age	Household Monthly income	
1. ☐Married. 2.☐Single *Gender* 1.☐Male 2.☐Female	1.☐None 2.☐Primary 3.☐Secondary 4.☐College	1.☐Formal work 2.☐Informal work 3.☐Trade 4.☐House rental fees 5.☐Children support	1.☐Moslem 2.☐Christian 3.☐None	1.☐<15 2.☐15-24 3.☐25-34 4.☐35-49 5.☐50-64 6.☐> 65	1.☐<10,000 2.☐11- 20,000 3.☐21-30,000 4.☐31-40,000 5.☐41-50,000	6.☐51-60,000 7.☐61,-70,000 8.☐71- 80,000 9.☐>80,000

Radio?	Own a phone	Own a TV	Own maize garden in the city	Is there a refuse pit
1.☐Yes 2.☐No	1.☐Yes 2.☐NO	1.☐Yes 2.☐No	1.☐Yes, my own garden 2.☐No 3.☐Yes, rented garden	1.☐Yes 2.☐No

Telephone number:

If there are other questions that you are not able to answer I will be able to ask your spouse but also to find out whether you will be successful to build the facility you have selected.

Latrine observations

Roof	Superstructure	Door	Bathroom water into toilet	Hand wash facility	Soap for hand wash
1.☐Thatched 2.☐Iron sheets 3.☐Tiles 4.☐Tin roof 5.☐Plastic 6.☐No roof	1.☐Burnt brick 2.☐Mud brick 3.☐wood 4.☐Mud house 5.☐Grass 6.☐Reeds	1.☐Wooden 2.☐paper 3 ☐cloth 4.☐No door	1.☐Yes 2,☐No	1.☐Yes 2,☐No	1.☐Yes 2,☐No

Housing observations

Roofing	Wall	Floor	Water Source	Electricity
1.☐Thatched 2.☐Iron sheets 3.☐Tiles 4.☐Tin roof 5.☐Plastic	1.☐Burnt brick 2.☐Mud brick 3.☐wood/Plank 4.☐Mud house 5.☐Grass 6.☐Reeds/straw	1.☐Cement 2.☐Mud 3.☐Tiles	1.☐Water kiosk 2.☐piped into yard 3.☐Piped into house 4.☐public tap 5.☐Borehole 6.☐Well	1.☐Yes 2.☐No

Location of house surveyed

Easting								***Northing***							

Closing remarks:

Thank you very much for your time and answers. Do you have any questions that you want to ask me? I will come again in the near future to see your new toilet.

Comments: (any comments about the interview itself, the person being interviewed)

_____

Appendix 13: List of low-income urban areas selected

#	Lilongwe City		#	Blantyre City	
	Low-income area	Sample		Low-income area	Sample
1	Area 22	37	16	Bangwe	41
2	Area 23	40	17	BCA	39
3	Area 24	50	18	Chilobwe	40
4	Area 25B	40	19	Chilomoni	36
5	Area 25A	39	20	Machinjiri	40
6	Area 36	47	21	Manase	40
7	Area 50	40	22	Manyowe	31
8	Biwi	37	23	Mbayani	121
9	Chilinde	40	24	Misesa	40
10	Chinsapo	82	25	Nancholi	40
11	Kawale	32	26	Naotcha	37
12	Mchesi	40	27	Ndirande	145
13	Mgona	39			
14	Mtandire	47			
15	Mtisriza	40			
		650			650

Appendix 14: Ethics approval - Ministry of Health, Malawi

Telephone: + 265 789 400
Facsimile: + 265 789 431
e-mail doccentre@malawi.net
All Communications should be addressed to:
The Secretary for Health and Population

In reply please quote No. MED/4/36c

MINISTRY OF HEALTH
P.O. BOX 30377
LILONGWE 3
MALAWI

7th March 2013

Richard Chunga
London School of Hygiene and Tropical Medicine

Dear Sir/Madam,

RE: Protocol # 1139: Investigating household sanitation technology preferences in low income urban areas: Lilongwe and Blantyre City- Malawi

Thank you for the above titled proposal that you submitted to the National Health Sciences Research committee (NHSRC) for review. Please be advised that the NHSRC has **reviewed** and **approved** your application to conduct the above titled study along with the following documents:

APPROVAL NUMBER **: NHSRC # 1139**

The above details should be used on all correspondence, consent forms and documents as appropriate.

- **APPROVAL DATE** : **07/03/2013**
- **EXPIRATION DATE** :This approval expires **on 06/03/2014**

After this date, this project may only continue upon renewal. For purposes of renewal, a progress report on a standard form obtainable from the NHSRC secretariat should be submitted one month before the expiration date for continuing review.

- **SERIOUS ADVERSE EVENT REPORTING** :All serious problems having to do with subject safety must be reported to the National Health Sciences Research Committee within 10 working days using standard forms obtainable from the NHSRC Secretariat.
- **MODIFICATIONS**: Prior NHSRC approval using standard forms obtainable from the NHSRC Secretariat is required before implementing any changes in the Protocol (including changes in the consent documents). You may not use any other consent documents besides those approved by the NHSRC.
- **TERMINATION OF STUDY**: On termination of a study, a report has to be submitted to the NHSRC using standard forms obtainable from the NHSRC Secretariat.
- **QUESTIONS**: Please contact the NHSRC on Telephone No. (01) 789314, 08588957 or by e-mail on doccentre@malawi.net
- **Other:**
  Please be reminded to send in copies of your final research results for our records as well as for the Health Research Database.

Kind regards from the NHSRC Secretariat.

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FOR CHAIRMAN, NATIONAL HEALTH SCIENCES RESEARCH COMMITTEE

Appendix 15: Ethics approval - London School of Hygiene & Tropical Medicine

London School of Hygiene & Tropical Medicine
Keppel Street, London WC1E 7HT
United Kingdom
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www.lshtm.ac.uk

Observational / Interventions Research Ethics Committee

Richard Chunga
DC / ITD
LSHTM

31 July 2013

Dear Mr. Chunga,

Study Title: **Investigating Household Sanitation Technology Preferences and Factors Affecting the Adoption of Ecological Sanitation in Peri-urban Areas.**
LSHTM ethics ref: **6443**

Thank you for your letter of 25 July 2013, responding to the Observational Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

Approval is dependent on local ethical approval having been received, where relevant.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
LSHTM ethics application	n/a	
Protocol		
Home Owner In-Depth Interview - Consent form		
Home Owner In-Depth Interview Guide		
Home Owner Survey Consent form		
Home Owner Survey Questionnaire		

After ethical review

Any subsequent changes to the application must be submitted to the Committee via an E2 amendment form. All studies are also required to notify the ethics committee of any serious adverse events which occur during the project via form E4. At the end of the study, please notify the committee via form E5.

Yours sincerely,

Professor John DH Porter
Chair
ethics@lshtm.ac.uk
http://intra.lshtm.ac.uk/management/committees/ethics/