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**Ecological sanitation in urban South Africa:  
socio-cultural, design and operational challenges  
of Urine Diversion Dry (UDD) toilets and the  
impact on users' perceptions**

*G. Matsebe<sup>1</sup>, A. Osman<sup>2</sup>*

<sup>1</sup>The Council for Scientific and Industrial Research (CSIR), Built Environment unit, Building 2, Room A244, P.O.Box 395, Pretoria, South Africa, 0001. E-mail address: gnmatsebe@csir.co.za

<sup>2</sup>Architecture Department, Faculty of Arts, Design and Architecture (FADA), University of Johannesburg, P.O.Box 524, Auckland Park, South Africa, 2006. Email address: amirao@uj.ac.za

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*Abstract:*

*The Urine Diversion Dry (UDD) toilet is a technology that offers a sustainable alternative to waterborne systems in a water-scarce country like South Africa. This technology has mostly been implemented in rural areas with limited applications in urban settings.*

*The paper presents a qualitative survey and analysis of the Hull Street medium density mixed housing (MDMH) project in Kimberley – this was carried out using a purposive sampling method. The findings revealed a high degree of dissatisfaction of the UDD technology leading the local municipality officials to decide to convert it into waterborne system.*

*The study shows that higher acceptance of this alternative technology could have been achieved if there was more buy-in from politicians and officials and active participation of users in the decision-making process.*

*An important reason for the rejection of the system is attributed to its design shortcomings. Some simple, cost-effective measures could ensure better performance of the UDD technology, better facilitate the operational aspects of the technology and ensure higher levels of acceptance.*

**Keywords:** *medium density mixed housing, socio-cultural perceptions, South Africa, urine diversion dry toilets,*

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## Introduction and background

Sanitation cannot be separated from housing. It forms an integral part of any housing development in the urban areas of South Africa, as it addresses disposal of human excreta in order to minimise the risk of transmitting diseases to the users (Matsebe, 2011).

While the South African Department of Water Affairs has attempted to provide alternative technical sanitation options in the form of both dry and wet systems, waterborne sanitation is still the predominant system in urban areas.

The renaming of the Department of Housing in 2010 meant that sanitation became an integral part of the, now called, Department of Human Settlements. The change in name implies a more holistic approach to the complexities of the built environment and the integration of housing and services towards complete, functioning residential environments. It was therefore deemed necessary to explore the integration of the UDD toilets in medium density mixed housing (MDMH) in urban areas. This paper presents the findings of a research study that sought to understand the socio-cultural perceptions and practices, and measured users' response to the UDD toilets in the Hull Street MDMH project in Kimberley. The study was qualitative in nature and used a purposive sampling method.

## The current situation

Water-borne system is currently the most used sanitation system in urban areas of South Africa despite water shortage projections for the country (Matsebe, 2011). South Africa is a water-scarce country (Otieno and Ochieng, 2004; Wassung, 2010). The current sanitation system mostly used in South African urban areas depends on extensive use of water in a form of flush toilets (see figure. 1). On the other hand, the housing sector in major cities is continuously growing and this is putting a strain on water services. The Department of Water Affairs provided a range of sanitation technologies in various parts of the country, both dry and wet. Examples include: waterborne (require piped water supply), ventilated improved pit (VIP) toilets, pour-flush, aqua-privy ecological sanitation (widely known as ecosan) in a form of a urine diversion dry (UDD) toilet, etc. The latter provides a reasonable solution to the current sanitation challenge.

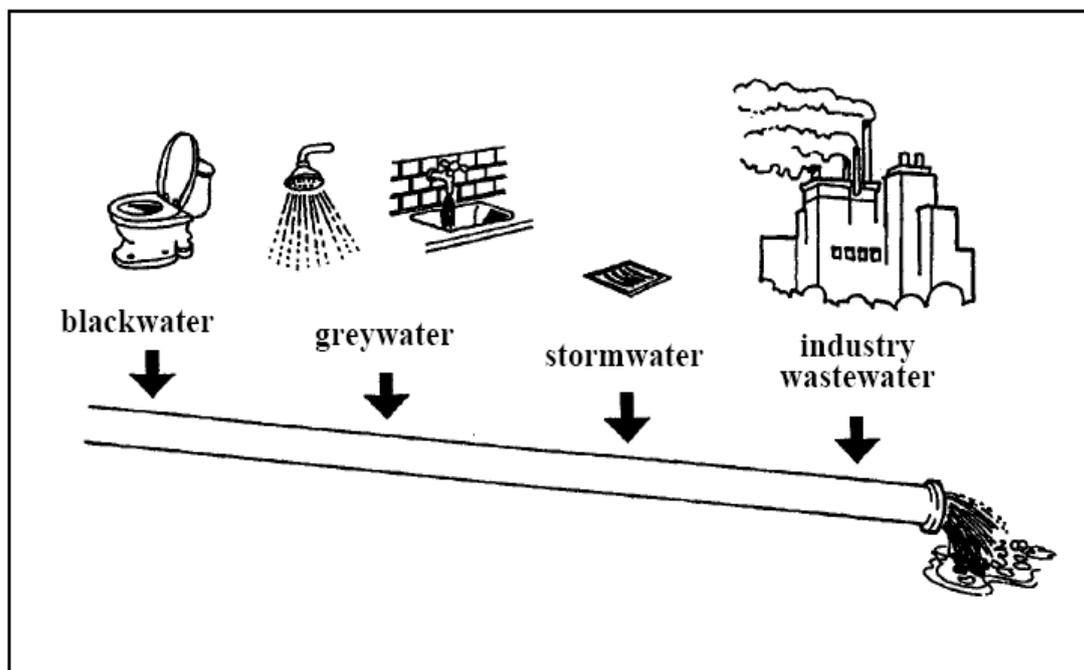
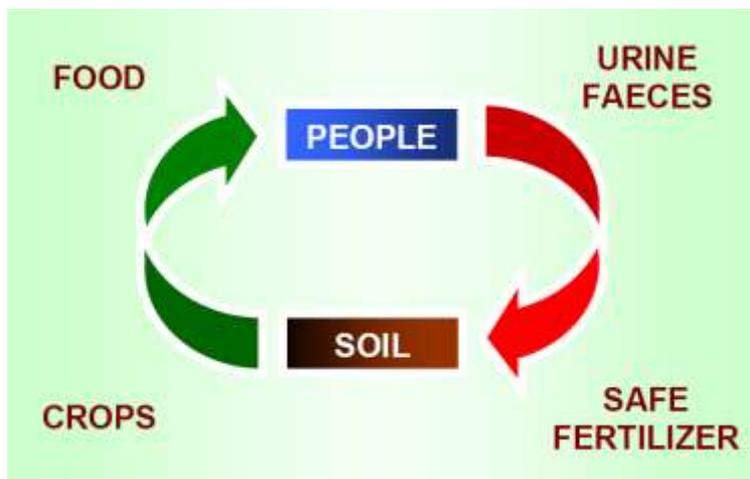


Figure 1: Linear flow system (Source: Esrey et al., 2001)

### Closing the loop: a sustainable approach to sanitation in urban areas

Ecosan or dry sanitation is one form of sanitation technology that does not use water, separates faeces and urine and is therefore considered to be a more sustainable option with less damage to the environment (Esrey *et al.*, 1998; Drangert, 2004; Austin *et al.*, 2005 and GTZ, 2009). According to Bracken *et al.* (2005) and SuSanA (2008), sustainable sanitation is defined as a system that protects and promotes human health, does not contribute to environmental degradation or depletion of the natural resource base, and is technically and institutionally appropriate, economically viable and socially acceptable (see figure 2, 3 and 4 below). In South Africa, the urine diversion dry (UDD) toilet is generally restricted to rural areas rather than urban settings.

Considering the rate of urbanisation and the lack of water resources, it is considered important to decentralise sanitation solutions and “close the loop” in terms of the cycle of waste and resources. For this reason alternatives need to be found for current unsustainable practices. While on-site solutions might not be feasible in a higher density, urban setting, solutions might include a precinct or neighbourhood approach with possible clustering options.



**Figure 2: Closing the loop on sanitation (Source: EcoSanRes, 2008)**

The Medium Density Mixed Housing typology is advocated in the Department of Human Settlements' comprehensive plan known as the 'Breaking New Ground' (BNG), mainly to address the spatial restructuring of South African cities (Department of Housing, 2004). The objective of BNG is to ensure that this housing typology has a greater mix, private space in a form of a garden, patio or balcony, as well as a higher density, than is currently the case (Landman *et al.*, 2007 and Osman, 2010). According to previous CSIR research, and based on the South African context, MDMH is defined as housing that has a minimum of 50 dwelling units per hectare (du/ha) and a maximum of 125 du/ha. These various densities have different spatial and physical manifestations. This definition is also relative with regards to the locality in question as inner city contexts may require a significantly higher density (*ibid*).

This programme encourages urban densification and integration of cities due to the previous regime urban planning (Landman *et al.*, 2007 and Osman, 2010). Part of the significant aspect of MDMH is its ability to accommodate a large number of people in a small space with easy access to services and facilities. Furthermore, Medium Density Mixed Housing refers to housing developments that are generally not more than four storeys, well-located close to social amenities and public facilities. The building typologies are varied and may include stand-alone houses (*ibid*). Sanitation technologies

used in MDMH have generally been conventional water borne systems, with a few exceptions (Matsebe, 2011).

### Medium density mixed housing development at Hull Street, Kimberly, South Africa



**Figure 3: A UDD toilet in Hull Street (Source: CSIR, 2011)**



**Figure 4: A UDD toilet with a kiddie seat in Hull Street (Source: CSIR, 2011).**

This paper comprises a part of a study undertaken towards a Masters in Development Planning at the University of the Witwatersrand in Johannesburg (Matsebe, 2011). The study sought to explore the socio-cultural perceptions of the users of the UDD toilets installed in the medium density mixed housing development of Hull Street in Kimberley, Northern Cape Province of South Africa, and the extent to which UDD toilets have been accepted or rejected by users. This will then inform whether UDD toilets are sustainable sanitation systems or not in this particular context, from a user's point of view (*ibid*).

Socio-cultural factors include amongst other diversity of cultural and societal norms, individual values, people's beliefs, attitudes and practices, religious conventions, user preferences and established practices that determine whether a novel approach will be accepted or rejected by its users (Drangert, 2004). Understanding the users' socio-cultural perceptions of the UDD toilet will contribute to future policy making, as the information can be used to improve the future roll-out of the technology in order to make it more acceptable (*ibid*).



**Figure 5: Double storey semi-detached units in Hull Street MDMH (Source: Landman *et al.*, 2009).**



**Figure 6: Single and double storey units in Hull Street MDMH (Source: Landman *et al.*, 2009).**

### Research methods

Qualitative research seeks to understand feelings, experiences, social situations, or phenomena in their real or natural setting (Terre Blanche *et al.*, 2006). Phenomenological research design was used (Matsebe, 2011). The focus of the phenomenological research design is on understanding social and psychological phenomena from the participants involved (Welman *et al.*, 2005).

The study was qualitative in nature with the aim of gathering diverse opinions and responses. The research used a case study design which refers to “an empirical inquiry that investigates a contemporary phenomenon within a real life context, when the boundaries between phenomenon and context are not clearly evident, and in which multiple sources of evidence are used” (Yin, 1984:23).

The sample size comprised 16 users or participants, 13 of whom were residents of the Hull Street and three were employees of the Sol Plaatje Housing Company (SPHC), which oversees operation and maintenance of this housing project.

The sample was selected by a purposive sampling method, also known as judgemental, subjective or selective (Laerd, undated). When using this technique, the researcher selects participants with a specific purpose in mind (Neuman, 2003). The following characteristics were considered when selecting the sample: race, gender, position in the household (head of household or spouse), age, language, duration of stay in Hull Street, preference for the UDD sanitation system and unit size.

Semi-structured interviews were conducted using an open-ended questionnaire. The use of open-ended questions in qualitative research is critical, as no clues are provided and provision is made for a greater depth of response. The interviewer can deviate from the specific core questions to explore in-depth information and probe according to the way the interview proceeds, allowing for elaboration (Neuman, 2003). Other benefit of conducting interviews is that the interviewees have an opportunity to ask for clarity in the event of misunderstanding. In addition, the interviews provide an opportunity to evaluate and validate the respondents’ answers by observing non-verbal cues, such as avoidance of eye contact or nervousness. Interviews lasted for 45 to 60 minutes.

A Dictaphone recorder was used in this study to record the interviews after respondents granted permission. Transcription of the Dictaphone recordings was time-consuming especially since translations (from Afrikaans) were done by the researcher and an external expert /transcriptionist.

While being time-consuming, field notes were taken to allow the researcher to document non-verbal behaviour and responses (Welman *et al.*, 2005) and it also stimulated the researcher's memory of things said at the time that were not included in the original notes. The data was analysed by means of content analysis, which enabled the researcher to identify important themes for the study by counting the frequency and sequencing of particular words, phrases or concepts (*ibid*).

A pilot study was conducted as a preliminary run that provides an overview of the subject to be studied prior to implementing the study on a large scale. This exercise is necessary as it helps to identify potential problems with the design, particularly the research instruments (Terre Blanche *et al.*, 2006). Unclear questions were restructured and some were replaced during the pilot study.

## Results and Discussion

This section looked at detailed findings of the study and related discussions categorised into four themes. The overall results of the study revealed dissatisfaction regarding the use of the UDD toilet, which emanates from poor design of the toilet facility

The findings of the study were categorised into four themes:

### *Design, use and functionality*

Most of the users reported that the UDD toilet was unhygienic, unhealthy, had an uncomfortable sitting position, released unpleasant odours and had high operation and maintenance costs. It was therefore found to be very difficult to use. due to its design, especially in terms of sitting positions as one has to aim properly when sitting depending on the purpose of using the toilet (urinating or defecating). This is consistent with McConville and Rosemarin's findings (2011) that it is necessary for the design of this toilet to be appropriate as inferior or incorrect design of a UD toilet was a barrier towards the acceptance of the technology. This is further supported by Duncker *et al.*, (2006) in four South African provinces that revealed that the design of a UD toilet can influence user acceptance (2006). This study showed that the users liked UD toilets only when they were convenient, safe and comfortable, reduced the spread of diseases did not use water and were properly built (*ibid*).

In addition, some users found it a daunting task and embarrassing to explain to visitors how the toilet functions. This ultimately resulted in the incorrect use of the toilet. This was also found in McConville and Rosemarin's study (2011), which highlighted the following reasons cited by the users for rejecting the technology:

- toilets were perceived to be awkward to use and explaining their function to visiting family relatives and friends was considered an embarrassment and an unnecessary burden and the major barrier (such as in the China-Sweden Erdos Eco-town Project (EETP)
- it was also indicated that the major barrier for this project was household acceptance.

Consequently, the sustainability of the solutions was questioned because of user resistance (*ibid*).

It was also revealed in the study that the design of the toilet poses health risks, particularly for some women, who said that they found it uncomfortable to use the toilet and that when

the wind blows in whilst they are using the toilet. This was perceived to be a reason for contracting infections (suffering pains from the womb). This is in line with literature by McConville and Rosemarin (2011) indicating that poor design of UD toilet can cause health risks from unhygienic exposure to pathogens and hazardous substances by the application of this specific sanitation system.

#### *Operation and maintenance*

The findings of the research showed that, even though maintenance measures to address odour have been put in place such as the installation of fans and use of lime to cover faeces, participants still find the odour disturbing, especially when cleaning the toilet. This is supported by Drangert (2004) indicating that measures could be taken for better maintenance and installation of ventilation pipes, use of air fresheners and application of ash onto faecal deposit in UD toilets to minimize the smell.

The researcher found that the Hull Street residents followed some of these suggestions and did apply lime on top of faeces after defecation as well as used detergents and disinfectants to keep the UDD toilet clean and alleviate the smell. They also indicated that since the maintenance people from the SPHC collect bags of faeces once a week, they (the participants) had to pay R10 for extra collection in that week (two or three times) as they felt that collection once in a week was not enough because the vault was small and smelled when faeces was stored for a longer period. This is consistent with one of the reasons for users rejecting the UDD technology in the China-Sweden Erdos Eco-town Project (EETP) owing to unwillingness of the local government to incur the cost of collection and maintenance (McConville and Rosemarin, 2011).

#### *Users' perceptions and attitudes*

The results of the study indicated that almost all respondents stated that they did not prefer the UDD toilet and would not recommend it to other people. They felt that they would rather have a flush toilet, even referred to it as "the right toilet". In addition, participants highlighted that they did not like the UDD toilet as they perceived it to be unhygienic, smelly and unhealthy. Drangert (2004) concurred with this statement pointing out that aesthetic aspects such as smell and the appearance of human excreta play a pivotal role in acceptance or rejection or avoidance of a sanitation system.

Similarly, users of UD toilets in Linz, Austria, face challenges in accepting the toilets owing to operational shortcomings such as odour from the wrong deposition of faeces in the urine receptacle (Ulrich, 2009). Despite the fact that one of the benefits of installing the UDD toilet is the production of fertiliser from nutrients in human excreta, participants did not buy into this idea as most of them felt that they did not need or use it in the garden. They considered it waste, and hence would rather have a flush toilet. This is supported by the study conducted by Duncker *et al.* (2006), in four provinces of South Africa (North West, KwaZulu-Natal, Northern and Eastern Cape) where it was indicated that a UD toilet can be accepted as a toilet but its major barriers may be emptying of the vault, handling of human faeces and the reluctance of users to use the products (excreta) from the toilet.

In addition, handling of human excreta in South Africa remains a general challenge since faeces are perceived as waste products, unhealthy, unhygienic and detrimental to humans (Duncker *et al.*, 2007). The participants perceived UDD toilets as unpleasant and unhealthy due to offensive odours (Duncker *et al.*, 2006). One of the purposes of implementing the UDD toilet was to cut down costs in terms of water usage, but the results obtained could not show any difference in terms of cost savings, as participants still spent a lot of money on cleaning detergents and antiseptic, as well as paying for extra collection service as previously mentioned. This is supported by Esrey *et al.*, (1998); Drangert, (2004); Austin *et al.*, (2005) and GTZ, (2009) who state that the benefits of a UDD toilet is that it uses little or no water for flushing, while a flush toilet uses 8 to 12

litres per flush (GTZ, 2009). This results in a cost saving for both users and the service provider (municipality).

Moreover, the UD toilet recycles phosphorus from urine, may also create business opportunities through the sale of UD toilets and the fertiliser generated, there is less odour from separated faeces and urine, it can be indoors and minimises toilet-related groundwater pollution with nitrates and pathogens (*ibid*). In spite of these benefits, respondents felt that the operation and maintenance of the UDD system was very costly. This is in line with the EETP study that emphasized one way of enhancing the acceptance level by users is that of implementers ensuring that the cost-benefit ratio for the overall system is acceptable when compared to the conventional waterborne system (McConville and Rosemarin, 2011). Costs for operation and maintenance (O&M) should not be higher than for the flush-system or they should experience direct benefits (*ibid*).

#### *Sociocultural influences/impact*

The obtained results revealed that Muslim participants felt that some of the principles of the UDD toilet conflict with their culture of using water for anal cleansing, thus influencing their reluctance towards a UDD toilet. This statement is consistent with the literature by Nawab *et al.* (2006), which indicated that it was common practice in Muslim cultures to keep water in the toilet for anal cleansing. The Islamic religion requires cleaning of all body openings, including anal cleansing as a common practice for purification rituals prior to praying.

In addition, Machaki villagers in the North West Frontier Province in Pakistan preferred a squatting commode installed in a north-south direction to avoid facing Mecca. The reason behind this preference (squatting commode) was mainly because it was considered to be ideal for anal cleansing, which is difficult to follow when using urine diversion toilets or common sitting commodes (*ibid*).

The findings of the study showed gender bias in terms of cleaning the toilet. Most informants cleaning the toilets were females who were responsible for the upkeep of the entire household. Although they did not like cleaning the UDD toilet, they felt obliged to do so since it was part of general cleaning of the household. This is supported by Drangert (2004) pointing out that in African cultures, females were generally responsible for chores in the kitchen and bathroom/toilet, while men carried out construction, the repair of installations and emptying the urine container and faecal vault.

#### **Suggested design considerations in the design of UDD toilets**

The Hull Street project demonstrates how design and technical detailing faults could be a major factor in the rejection of a technology solution that is in theory extremely relevant and useful for the context. Some of the concerns are listed as follows:

- The toilet seat needs to be better designed to allow for ease of use for children and adults – the system should also be easily understood to visitors and should not need much effort and explanations.
- The odor and wind issues need to be resolved through better design and the toilet must also be aesthetically pleasing in its interior design. This needs design resolution in section, in terms of material selection, colours and constriction detailing.
- Access to the toilet shaft/waste container must be at the back of the building and not visible to visitors. It must also not be easily accessible to children for hygiene and safety purposes. Currently, the container is positioned behind an easy to open flap at ground level in a visible location. The size of the container is similar to a bucket size and the fact that it is easy to access and visible is reminiscent of the

much-hated bucket system. The size of the container is also problematic in that it needs frequent emptying causing even more rejection of the system.

- By re-designing the way that the buildings are clustered, the access area could also be visually screened from the front door and shared communal spaces so that collection could take place with interference with children's play areas or visitor's access areas. Simple re-planning of the development could have resolved many of these issues.
- An alternative clustering of the housing may have also facilitated off-site collection at a central point to counter the negativity of having an on-site collection point. This may have been achieved through simple re-positioning of the house on the plot and in relation to the street. A service alley might be a solution for future developments.



**Figure 7: Eco-blocks plan of Hull Street**



**Figure 8: Indoor UDD toilet in Hull Street (Source: CSIR, 2011).**



**Figure 9: UDD toilet, hand basin and a shower in a bathroom (Source: CSIR, 2011).**



**Figure 10: Door to access a faecal vault from outside the housing unit (Source: CSIR, 2011).**



**Figure 11: Back view of the Hull Street project (Source: CSIR, 2011).**

## Conclusions

The study revealed that majority of interviewees had previously used waterborne systems and regarded the UDD toilet as inferior, backward and unsuitable for modern urban areas. The UDD toilet is associated with the bucket system. The findings of the study revealed a high degree of user dissatisfaction regarding the use of UDD toilet, which emanated mainly from poor design. Most users preferred a flush to the UDD toilet, owing to the latter system being viewed as unhygienic and unhealthy, had an uncomfortable sitting position, released unpleasant odours and had high operation and maintenance costs. Furthermore, the UDD technology lacked institutional support from politicians and officials at the local municipality, who eventually decided to convert it into waterborne system. This could have contributed to low acceptance of this technology.

The UDD toilets need to be well designed and convenient to use in order to enhance the acceptance level of the users. Inferior or incorrect design of UD toilet was highlighted as a barrier to the acceptance of the technology. Appropriate design, coupled with a lack of or very little smell of faeces and urine is likely to contribute towards the rate of acceptability of UDD sanitation arrangements. Implementation of ecosan might counter the challenge of water scarcity faced by the country.

The operation and maintenance cost of the UDD toilet was higher than that of a flush toilet as respondents spent lot of money on detergents and disinfectants to clean the toilet and reduce odour. A small faecal vault contributed towards the increased cost of maintenance in that it needed to be emptied frequently at a cost to the users (residents). The extractor fan also consumed lot of electricity, hence was used minimally or not at all.

Some of the challenges experienced by the Hull Street respondents are similar to those encountered by the users of UDD toilets in the China-Sweden Erdos Eco-town project (EETP). These include, inter alia, incorrect or uncomfortable design of the UDD toilet (e.g. awkward to use), the high cost of operation and maintenance of the toilet and the embarrassment in informing visiting family relatives and friends on how the UDD toilet functions. Non-acceptance of the UDD toilets ultimately resulted in conversion of the system into a waterborne system. Likewise, the incorrect design of the UD flush toilet at a primary school in Linz, Austria was converted into flush toilets owing to the big size of the toilet for small children.

## Recommendations

Planning is political. There is a need for a buy-in from politicians for the success of developmental projects. Despite efforts put by the SPHC to promote and provide training on the UDD systems, the project could not succeed owing to lack of political support (for

the project). User interface is the key consideration for the success of a UD toilet (McConville and Rosemarin, 2011). Henceforth, the UD toilets must be of the right design and convenient to use, as people might be cautious and take time to understand the systems well before they adopt them. It is therefore, necessary to ensure that potential users are thoroughly engaged throughout the process in order to be well informed about the UDD sanitation system and future projects.

Since South Africa is a water-scarce country, there is a need for government to invest in educating the general public (including politicians and government officials) on the wider benefits of the UDD sanitation technology and environmental sustainability aspects of the UDD technology, so as to change perceptions about it. The UDD sanitation system is in this regard one of the possible solutions towards addressing this challenge as it is a waterless system

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An integrative approach to housing and UDD sanitation supply is recommended, where both fields are viewed as equally important issues in delivery of sustainable human settlements. Therefore, it is of great significance for future research to explore the UDD system addressing the key challenges that are design-related.

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