



# Approaches for bridging the sanitation delivery gap in urban informal settlements in Namibia

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## ARTICLE INFO

### Keywords:

Decentralised sanitation  
Wastewater  
Sewage  
Pit latrine  
Governance  
Urine source separation

## ABSTRACT

Shacks in urban informal settlements will be the most common form of housing in Namibia by 2025. Informal settlements are usually not connected to municipal sewage systems for multiple reasons, including lack of land tenure and lack of official capacity to invest in infrastructure in unplanned spaces. On-site decentralised sanitation is therefore the norm for shack dwellings in Namibia, but any official opposition to this system results in complete absence of sanitation and inadvertently promotes open defecation. This grey zone of urban informality and the gap in sanitation delivery is the focus of this study, which evaluates interactions between local communities, non-government organisations (Clay House Project and Development Workshop Namibia) and an international development agency (GIZ) as they navigate the physical, economic and political landscape of implementing bottom-up sanitation solutions for informal settlements in Namibia. In critical analysis of the three different sanitation delivery models of these organisations, we consider their historical development, underlying philosophies and technical solutions. We also examine how products from different sanitation systems are managed and whether urine source separation could improve their management. Overall, the results provide insights into bridging gaps in sanitation delivery in informal settlements, which are home to more than a billion people worldwide.

## 1. Introduction

Globally, more than a billion people live in informal settlements [1]. These settlements develop outside the physical and regulatory boundaries of a formal city and outside the control of government [2]. They also generally remain unconnected to municipal services such as piped water supply, sewage systems and garbage collection, because governments do not have the capacity or the willingness to service them [3], especially in developing countries.

Namibia is the most arid country in southern Africa. It receives average annual rainfall of about 250 mm, but almost 83 % of this evaporates immediately as the vegetation cover is sparse [4]. Although Namibia has low population density, around three inhabitants per km<sup>2</sup> according to United Nations [5], it has seen rapid urbanisation over the past two decades, with people migrating to urban centres and rural areas being incorporated into urban areas, resulting in sprawling informal settlements on the urban periphery [6]. Namibia's urban population tripled from 1991 to 2011 and in 2018 reached the threshold for

becoming an urban society. It is estimated that up to 40 % of the total population of around 2.6 million currently live in 228,000 shacks across Namibia and, based on national trends, shacks will be the most common form of housing by 2025 [7]. By 2050 75 % of the population will be living in urban areas [8], most likely largely in informal settlements without access to municipal services like centralised wastewater treatment. These settlements are incorporated *peri*-urban areas from what used to be communal areas of ethnic homelands under Apartheid or growth on the urban periphery of former colonial settler towns. For instance, areas in the northern regions of the country which were once under tribal rule and largely based on a lifestyle of subsistence during Apartheid have densified substantially into a meshwork of *peri*-urban villages. To bring development to these communities, villages are increasingly being incorporated into municipal administrative systems. Similarly, former colonial towns have experienced considerable inward migration from rural areas since Namibia's independence from South Africa, reflected in the explosion of informal settlements around the urban periphery, usually on municipal land [9]. In the capital city

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<https://doi.org/10.1016/j.cacint.2023.100120>

Received 11 August 2023; Received in revised form 8 September 2023; Accepted 12 September 2023

Available online 12 September 2023

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Windhoek alone, the population has nearly doubled in size over the past decade (from 270 000 in the last national census in 2011 to estimates ranging widely from 420 000 to 600 000), manifesting in about 68 000 new shacks. The heterogeneities of spatial formation on the urban periphery and *peri*-urban incorporation are similar in nature to other majority world contexts, yet specific to the arid Namibian condition, where sprawling low-density townships make it impossible to capitalise on the agglomeration efficiencies associated with urbanization.

According to data available from the Joint Monitoring Program (JMP) of UNICEF and WHO [10], 85 % of households in Namibia had access to basic drinking water services in 2020, but only 35 % had basic sanitation services and 47 % of households at the National level had to resort to open defecation. While there are many intersecting reasons for the massive discrepancy between levels of access to water and access to sanitation, it can primarily be ascribed to the fact that water is delivered through shared communal standpipes with prepaid meters which are relatively easy to roll out and many municipalities increase their revenue base by selling water at a premium [11]. In rural areas of the country, only 20 % have access to basic sanitation with 75 % of this 20 % (15 %) making use of pit latrines while a staggering 71 % resort to open defecation [10]. In urban areas 50 % have access to basic sanitation and 25 % resort to open defecation [10]. However, it is important to highlight that much of the data was gathered in the 2013 DHS survey and the last national census conducted in 2011, suggesting that it needs nuanced reading and updating. The rural population is decreasing and the percentage of urban residents living in informal or *peri*-urban conditions is increasing. This suggests that the issue of sanitation in Namibia is increasingly an urban problem, since rural areas have densified and have been incorporated, or residents have moved to low density informal areas on urban peripheries, but this is not yet reflected in the JMP data and has not been the subject of comprehensive studies.

At informal settlements in Namibia, technical constraints such as irregular urban morphology, challenging topography, and lack of financing make centralised water-borne sewage systems largely unfeasible. Moreover, because of the arid climate, there is simply not enough water available to convey sewage in a centralised system. Local authorities are also often unwilling to invest in connecting these settlements to the sewer network because they lack land tenure and are perceived as being illegal. Therefore, various low-cost decentralised sanitation systems, e.g. pit latrines, are the norm in Namibia [12]. However, these solutions tend to face resistance on the managerial and bureaucratic front. This is especially true in the case of shared sanitation facilities which are generally rejected by communities and politicians due to lack of ownership and accountability, which ultimately leads to their failure. They are also perceived as sub-standard (not meeting the gold standard of flush toilets) or non-compliant from a regulatory perspective. The opposition to on-site and communal systems results in a complete lack of sanitation or forces communities to develop their own solutions (typically pit latrines), leaving them in a legal grey zone that is typical of urban informality [13]. It also inadvertently encourages residents to defecate in the open, in spaces such as riverbeds and peripheral green areas, resulting in environmental risks and negative health impacts e.g. hepatitis E virus outbreaks in Windhoek [11].

A major reason for the lack of progress in addressing issues of sanitation at informal settlements is political interference in technical and operational matters [11] [14]. After independence, the Namibian government aspired to provide water-flush toilets and mixed sewage collection for all citizens. However, providing such a system to informal dwellings would require moving residents (re-blocking) as part of a surveying process, land proclamation and finally sewage installation, all presenting major bottlenecks. A second reason why politicians insist on waterborne sewage systems is because they believe that Namibia possess technical capacity to treat domestic wastewater. The Goreangab reclamation plant in Windhoek, where outgoing effluent from the city's sewage treatment plant has been directly reclaimed as potable water since 1969, provides the government with a 'suitable' technical solution

[15]. The reclamation plant is truly novel and only one of a kind that is in operation for several decades. Consequently, it regularly features in popular media and academic literature as a case study, overshadowing broader sanitation issues in Namibia. While the Goreangab reclamation plant remains technically impressive, it cannot address inherent obstacles to extending sanitation delivery to informal residents. Despite upgrades to the reclamation plant on several occasions, the sewage connection rate in Windhoek has been greatly outpaced by the proliferation of informal settlements. Additionally, it ignores the fact that even if it were possible to connect these settlements to the reclamation plant, the amount of water required to convey sewage would not be sufficient.

The majority of the decentralised sanitation systems in Namibia are self-built and supported by the ongoing work of NGOs and international development agencies. These organisations operate symbiotically and seek pragmatic solutions that could have impact at scale, although their approaches vary widely. However, little is known about the ways in which these organisations and communities in informal settlements operate and navigate the physical, economic and political landscape when implementing bottom-up solutions and delivering sanitation to informal settlements in Namibia. In this study, we aimed to address this research gap by examining this ecology to evaluate how the impact of such organizations on sanitation delivery can be maximized. We interviewed representatives of the most prominent organisations that are active in the informal sanitation space to identify influencing forces, perceptions and motivations that have developed since 2000, and how this gave birth to the current landscape in which the NGOs, activists, researchers and community members operate. We then compared the different models for sanitation delivery in Namibia, considering technical, financial and social dimensions. Lastly, we evaluated alternative sanitation systems such as those based on urine source separation and recycling regarding their potential for use within the existing paradigm, considering the scope afforded by legal grey areas.

## 2. Methodology

A series of semi-structured interviews were conducted following a topic guide with representatives of three organisations: Clay House Project and Development Workshop Namibia (NGOs) and the German Agency for International Cooperation (GIZ). Participants were selected based on the broader theoretical discourse relating to development and urbanism, and their intrinsic roles within the sanitation sector in Namibia. GIZ and DWN were selected as the two most prominent organisation currently active in the context and the only organisations with programmes expressly focused on sanitation, while the Clay House Project was deemed to have the most in-depth historical experience of the topic over a period of two decades. Additionally, all three organisations were deemed to potentially have an intrinsic alignment of interest with the research pertaining to urine source separation and recycling. The purpose of the interviews was to develop a thematic analysis of data which serves to frame further participatory research and co-production of research between the researchers and the respective organizations who provide context-specific and operational expertise. Thus, the research involves bi-directional exchange between academia and NGOs, and the thematic analysis informs further research which takes on a more discursive character.

GIZ and DWN have ongoing research partnerships with the *Department of Architecture, Planning and Construction* at the *Namibia University of Science and Technology*, in various domains related to urbanism and architecture. Although there are existing agreements in place, letters in support of the proposed partnership were also provided by the organisations. Simultaneously, they represent two distinct sanitation models operating in Namibia and offer contrasting perspectives. DWN's model focuses on achieving speed and scale, while GIZ works at multiple scales to allow for systemic change, with both systems working symbiotically. The Clay House Project was selected to provide historical background as

the *Otji-Toilet* they developed was a prominent reference for Namibian-developed decentralised sanitation and was the only organisation with experience in the field over two decades that they were active.

The management of all three organisations were contacted, the project was explained and interviews with technical and managerial staff were requested. Participants were made aware of the intentions and procedures of the interview. They were informed that data would be used anonymously and confidentially, and that they could withdraw from the study at any time and that anything shared off the record would not be used. The selected interviewees had a managerial and/or technical role within their respective organisation, allowing for an integrated picture of the underlying philosophy and how it manifested in technical solutions. In some cases, the interviewees consulted colleagues for technical or managerial information. During subsequent analysis of the data, any missing information was collected through phone interviews and email requests and was compared against documents published by the respective organisations. Summaries of the interviews were not sent to the participants but will be presented during a roundtable discussion as part of a future workshop. This was done to prevent priming which may result in defensive attitudes and the purpose of this research is to foster collaboration between organizations.

Clay House Project opted to have a combined interview with the managing director and co-founder, as well as the technical specialist. For DWN, the national programme coordinator for sanitation was the primary respondent. For GIZ, the primary respondent was the team leader for Inclusive and Sustainable Urban Development (ISUD) project, supported by two members of the technical team. With the respondent's consent, open-ended conversations conducted in English were recorded and transcribed, and the transcripts were analysed as part of a thematic analysis which frames further discursive analysis to be conducted subsequently. Respondents spoke in their official capacities, and no personal data was recorded except for the respondent's role within their organisation. Any responses that were the respondent's personal view (not that of the organisation) or information they provided 'off the record' was redacted and excluded from the study. Additionally, any information that was deemed potentially detrimental to any other participants, the broader public or the good faith of a research partnership was excluded.

Both authors participated in the interviews, providing a *trans-disciplinary* perspective that brings together urban and policy related issues and technical sanitation expertise from environmental engineering. The interviews were directly followed by a discussion among the authors, where key insights, observations or opinions were noted and compared with other interviews. During these discussions the authors also reflected on their own perceptions and the relationship with the participants.

The interviews focused on identifying motivations, barriers to action and operations by NGOs and the government at various scales (local, municipal, national). Interviewees were given a brief introduction to the research project. The aims of the study and the topics of interest were explained. Following the topic guide, relatively easy and open-ended questions were posed first to ensure participants were comfortable and to allow them to respond elaborately. For this, respondents were asked to provide background information regarding why their projects were launched, how it was to be funded and what their aims were. The interviews progressed to unpack the organisation's approach to the main sanitation challenges including the economic model, management, policy, political landscape and community acceptance. Thereafter, respondents were asked to describe more abstract questions regarding their perceptions and how this informed the underlying philosophy of their organisation's approach to delivering sanitation services. Respondents were also asked to relate technical aspects such as project roll-out and scaling, and their organisation's philosophy to their objectives, with respect to speed, systemic change, and sustainability as it relates to funding models, timelines and deliverables.

Throughout the accounts, the main obstacles were noted down and

respondents were asked to provide insight into their nature, whether technical, economic, or normative. Normative aspects relate to perceptions such as community acceptance and political motivations, while technical aspects related to technology, policy, or regulatory standards, and economic aspects related to financing conditions such as project timelines and funding conditions and/or affordability. Several constraints were economic in nature, including the need to comply with programme timelines and funding conditions. Respondents also reflected on the challenges they foresaw regarding technical integration as well as technology adoption. This included the role of communication and/or education on sanitation technologies as it relates to social norms and political acceptance. The authors noted their perceptions and asked respondents to expand on specific dimensions, including how they thought urine source separation and recycling could best be integrated with their sanitation model. This elicited more elaborated responses and respondents were guided to speak to concrete technical, economic and normative dimensions of urine recycling.

All interviewees identified informal settlements as the focus of their work and comparisons between interviews were used to corroborate information provided by other respondents on different urban sanitation issues (described in the previous section of this paper and existing literature). Where statements could not be corroborated across interviews or supported by existing literature, they were treated as being specific to the organisational model or context and served to inform a discussion regarding their positionality as well as their relative strengths and weaknesses.

Respondents generally presented information in chronological order and addressed structural issues such as perceptions, politics, and economics first, before describing how these inform their models and accompanying technical solutions. In all cases, the interviewees were aware of the other two organisations participating in the study and often referred to what they had learnt from them, how they differ and how they collaborate, providing a cross-sectional picture of the ecosystem. In the analysis, the interviews were treated as case studies. The Clay House Project and *Otji-Toilet* provided historical background on delivering sanitation to informal settlements in Namibia, while the other two cases revealed contemporary approaches.

Finally, with respect to reflexivity, immediately upon completion of interviews, both researchers compared their notes and discussed their observations for their respective disciplinary perspectives. Having conducted the interview with Clay House Project first, the work of DWN and GIZ was discussed against a background of the historical development of the sanitation sector to understand how the landscape in which they operate has changed and allowing for speculation as to how the research partnership may unfold. We considered the relative strengths and weaknesses of the respective models and the roles of academic institutions in fostering collaboration.

### 3. Results

#### 3.1. Case study of the Clay House Project and its Otji-toilet solution

Clay House Project was born out of a concern to deliver housing to all people in the early years after Namibian independence from South Africa in 1990. At the heart of its philosophy was reducing reliance on external inputs such as expensive cement-based materials and empowering communities to build housing using locally available earth. In experiments inspired by the work of Egyptian architect Hasan Fathy, methods for earthen construction began to emerge, including techniques that reduced material cost and increased labour opportunities. Locally sourced raw materials have a smaller carbon footprint, are climatically responsive and eliminate the need for insulation by providing thermal mass [16]. Earth-building has been used in several arid regions worldwide and is well-established in vernacular traditions, with literature such as *Architecture for the Poor: An Experiment in Rural Egypt* reaching far beyond the confines of academia [17].

In post-independence Namibia, housing delivery increasingly took on urban dimensions such as land rights and service delivery [11,14]. Land delivery bottlenecks arose from the inability of municipalities to finance and deliver services like electricity, water, and sewage. The interviewees from Clay House Project indicated that these problems were exacerbated when Namibia was re-classified as a middle-income country in 2009, as this significantly reduced foreign aid and soft loans needed to finance development [18].

To unlock land and circumvent issues with tenure, the Clay House Project team opted to develop solutions that would not need municipal services. It represents a process whereby informal settlements incrementally become formalised since legally all land parcels need to be fully surveyed, planned and serviced to qualify as 'formal'. Thus, with the last round of European Union funding in 2002, construction started on surveyed, yet unserved parcels of land provided by local municipalities across Namibia, which beneficiaries had to buy over a period of 10 years. The team's focus then turned to development of decentralised sanitation solutions that could be connected to the municipal sewer network at a later stage. A self-funded, centralised sewage system was ruled out due to associated financing and operating costs. The interviewees indicated that, on average, it took 10 years for the first sanitation systems to be delivered, since local municipalities prioritised water delivery via collective water points spaced at 100-m intervals where residents could buy water (using a card with credits), which they carried home. Residents were also expected to pay a small municipal fee for services (e.g. garbage collection), but often did not do so because there were no adverse consequences of non-payment. In response, municipal authorities raised water prices, which made water expensive for the urban poor.

Considering the high cost of water and the labour associated with carrying buckets, the Clay House Project team opted for self-built, dry toilet systems. Treatment of wastewater was to be performed on-site, at the level of the individual toilet, through a process of drying and degradation of organic matter. Several commercially available systems from South Africa (e.g. Enviro Loo) were tested, reverse-engineered, combined and adapted to suit Namibian conditions. The final design (nicknamed *Otji-toilet*) resembled a hybrid between dry composting toilets and regular pit latrines, which could be produced using locally available materials, and came in the form of a kit of parts and an instruction manual. The design required a pit measuring 1.1 m × 1.8 m and 1.1 m deep, which if needed could be raised on a plinth. The pit was lined with bricks set on a 150 mm deep strip foundation. A concrete floorplate and pedestal were set on the brick wall before the superstructure was built. The base of the pit was constructed with perforated concrete slabs set on raised brick to allow liquid effluent to drain out and infiltrate into the soil. Two perforated 90 L drums were placed on the raised base and were switched out two or three times a year, allowing one to dry out while the other was in use. To the rear of the structure, a lidded box provided access to the pit for emptying and switching drums, with the construction manual suggesting it should face the equator to maximise solar heat gain.

The main technical challenges were associated with odours and handling of faecal sludge left in the pits, which only partially dried out (top 300 mm). This meant that the toilet could not be incorporated into the house and remained as an outhouse. The Clay House Project team tested various iterations to address these issues. For communal and shared sanitation systems, a solar oven into which drums were placed was tested, but this was not practical in urban settings and the core remained too wet and odours persisted. Tests showed that the upper part of the drum heated to 110 °C, but the bottom remained at 70 °C. To circulate air around the drums, a 3 m tall ventilation pipe was added, but this was not always sufficient. Solar photovoltaic cell-driven fans were tested for houses where toilets were not free-standing, but residents used the electricity generated for other household purposes. Finally, the team developed a urine-separating toilet, where surface tension caused by contact with the surface of the toilet bowl directed urine to a separate

outlet, while faeces flowed out through the main outlet. This toilet significantly reduced the water content in the pit, but never made it to the field as funding ceased before it could be tested.

The basic toilet developed by the Clay House Project was implemented in several towns across Namibia. These included Otjiwarongo, where approximately 500 toilets were built between 2003 and 2009 (hence the nickname *Otji-toilet*) and have been in operation for almost two decades. Due to the lack of other facilities today, residents allow neighbours to use their toilets, and consequently they are shared by 8000 people (450–470 toilets on various plots of land still operate), representing approximately 10 % of the 4000 plots in informal settlements, where more than half the town's residents live. The sludge in the pits is removed by a private contractor, who is paid by the municipality for this service and to transport it to municipal waste management facilities.

Ultimately, the programme stopped in most towns due to a combination of factors. Despite progress, technical challenges such as mal-odour persisted, which meant that toilets remained detached from houses and emptying of pits remained undesirable. However, according to the interviewees from the Clay House Project, political resistance was the most important challenge. For example, in the town of Gobabis, 112 out of 400 planned urine-separating toilets had been built when in 2010 the municipality halted all maintenance as it was "*rolling out a sewage system*", which is only being completed today, more than a decade later. The authorities also prevented households from implementing urine diversion and soil infiltration without any technical consultation, which effectively engineered technical failure of the *Otji-toilet* since it undermined the technical innovation which would allow faecal matter to dry more effectively. This was partly because local counsellors wanted to be seen to be delivering municipal services, but was also due to objections from central government since dry sanitation systems did not align with its post-independence aspirations of providing households with water-flush toilets and mixed sewage collection. In Windhoek, for example, in response to a central government demand that housing developments should only be permitted on fully serviced land, the municipality prohibited further development of self-funded housing, including the Clay House Project. Despite lacking expertise in the fiscal and technical challenges of sanitation, politicians maintained that only water-borne sewage, the standard in the Global North, would be acceptable.

According to the interviewees, the Permanent Secretary effectively stated that handling of excreta "*is work which cannot be accepted by freeborn Namibians*" (those born after Independence from South Africa), a statement they perceived as indicative of government attitude. This is supported by the literature, which suggests that it is often government bureaucracy that makes service delivery impossible [14]. The influence of bureaucratic changes in Namibia can be deduced from the name changes and restructuring of the relevant ministry. In 2000 it was called the Ministry of Agriculture, Water, and Rural Development (MAWRD), but was renamed the Ministry of Agriculture, Water and Forestry (MAWF) in 2010, split into two separate entities in 2015 (the Ministry of Agriculture, Water and Forestry, and the Ministry of Environment and Tourism), with both responsible for different aspects of water and sanitation, and by 2021 became the Ministry of Agriculture, Water and Land Reform.

### 3.2. Case study of development workshop Namibia

Development Workshop Namibia (DWN) was established in 2016 as part of a worldwide network funded by NGOs, private citizens, and national and international development organisations. DWN works through partnership agreements with local authorities and has four main programmes: housing delivery, early childhood development, urban infrastructure and, most recently (since August 2019), delivering sanitation in a dozen towns in Namibia. Their sanitation programme was created in response to hepatitis E virus outbreaks, which mainly affected informal settlements such as Havana and Goreangab in Windhoek [19].



DWN has three main intervention areas: i) raising awareness through a network of volunteers in informal settlements, with the focus on hygiene and construction of toilets; ii) building low-cost demonstration toilets according to World Health Organisation (WHO) standards and encouraging residents to build their own toilets; and iii) maintaining networks in communities with the collective aim of having an Open Defecation-Free (ODF), healthier and safer environment, especially for children and women. Information sharing is fundamental for the work of DWN, and its ArcGIS dashboard provides a monitoring platform for all its sanitation projects, alongside various publications available on its website.

DWN regards communities as agents that can construct their own solutions and assists them in meeting technical requirements. In Windhoek, for example, communities are not allowed to build their own toilets, as they do not meet municipal standards that favour centralised sewage systems. DWN works in this legal grey zone of urban informality where authorities do not recognise informal neighbourhoods as legitimate but also actively intervene and prohibit bottom-up solutions involving on-site sanitation. DWN steps in to present communities with designs for sanitation systems that meet the requirements set in existing institutional frameworks. It also collaborates with authorities to co-develop standardised designs and technical solutions for decentralised sanitation systems. At the political and technocratic level, DWN works to resist outright rejection of low-cost, self-built options. Overall, the DWN model serves to build trust between politicians, technocrats and the community.

The Community-Led Total Sanitation (CLTS) programme introduced by DWN starts by addressing perceptions and behavioural obstacles, making communities aware of the cumulative impact of open defecation at scale. A calculation tool makes collective impacts palpable in the strategy, which is intended to elicit disgust and a sense of urgency to mobilise communities to construct toilets. Once communities are made aware of the environmental and health risks, the technical requirements of pre-approved sanitation system designs are explained in a demonstration, where communities also learn how to build such systems. The demonstration systems are typically built at a strategic site, such as an early childhood development centre, and are funded by corporate sponsors or international development agencies. To comply with regulations the designs are simple water-flush toilets connected to a septic tank or dry pit latrines (in line with international guidelines developed by UNICEF and WHO), with the pit either lined or unlined to allow soil infiltration, depending on the context and municipal guidelines on groundwater quality. The superstructure may be built in regular brick or simply clad with corrugated sheeting, depending on the financial means of families, who generally opt to build for themselves or a small cluster of neighbours. The DWN model focuses on household-level owner-built and owner-operated solutions because they argue communities in informal settlements have historically preferred open defecation to shared sanitation facilities and because people are reluctant to invest their own capital in a communal facility.

The DWN case study revealed that many obstacles are not purely technical in nature and require extensive engagement of NGOs with local authorities and community members. The emphasis in the DWN approach is on education, as evidenced by its community engagement processes and its extensive list of publications targeting a diversity of readers and languages. The status of all of DWN projects is reported on its openly accessible ArcGIS dashboard. Overall, the DWN model seems to be successful in achieving scale, considering that it has built 71 demonstration systems since August 2019 and, as a result, 7348 latrines have been built across the country by residents of informal settlements in which DWN operates. However, its programme currently does not focus on emptying and management of the faecal sludge collected in the pits, tasks that are left to households. Based on their experience, the DWN interviewees suggested that the cost of emptying pits could be as much as a month's salary for community members.

### 3.3. Case study of GIZ's inclusive and sustainable urban development (ISUD) project

The German Agency for International Cooperation (GIZ) is an international enterprise owned by the German federal government. It is part of a larger diplomatic relationship between Germany and Namibia, engaging in the country at various scales, from the community and neighbourhood level to the municipal and national level, with the aim of improving inter-sector links and systemic cooperation. The GIZ view is that the efficiency and inclusivity, which are the core focus of its agenda, have a large cumulative effect. GIZ interviewees pointed out that conventional capacity development usually follows a sequence where the development partner demonstrates first, and then the local partner takes over for implementation. In contrast, GIZ incrementally builds capacity with the partner, learning through a collaborative process that is highly context specific.

This philosophical grounding is the backdrop against which the *Inclusive and Sustainable Urban Development* (ISUD) project, which works with urban informal settlements, was designed. Within the project, GIZ is working to change attitudes and build capacity with respect to town planning through co-designed experimentation, learning and demonstration. At the community and local authority level, various stakeholders across technical and political domains in partner towns work together. At the national level, at least three ministries (Ministry of Agriculture, Water and Land Reform (MAWLR), Urban and Rural Development (MURD) and Works and Transport (MWT)) take agriculture, land reform, urban land rights and urban mobility into consideration, along with various funding mechanisms. In Namibia, there has been no previous model of this kind operating down to the neighbourhood scale.

The ISUD project is time-limited, since it is donor-driven. It was started in 2020 in response to the outbreak of the novel coronavirus SARS-CoV-2, with relief funding channelled to sanitation in informal settlements. From an urban planning perspective, the project is also concerned with the development of settlements, place-making and the different functions in the settlement (e.g. recreation and green spaces). The project serves as a catalyst within GIZ's broader framework and learning model and will inform a successor project that will be implemented in 2024, with additional financial support for the agency's multi-scalar and multi-sector approach for integrated urban development. There is an important distinction between this approach and integrated sanitation, which focuses on the sanitation value chain, *i.e.*, safe collection, treatment, and recycling of resources (water, nutrients and energy) present in domestic wastewater.

In total, GIZ is working with 10 partner towns (five primary and five secondary) and the three ministries (MAWLR, MWT and MURD). At the start of the project, it carried out vulnerability assessment in terms of water and sanitation and concluded that shared sanitation in Namibia had a bad reputation due to challenges with ownership and maintenance. GIZ also determined that the ISUD projects should serve urban functions beyond sanitation. Thus, each facility was approached as a catalyst for other social functions, such as doing laundry or early childhood development, training, trading or sporting facilities. Pragmatically, GIZ acknowledges that only an initial portion of the project can be funded. It is therefore taking an incremental approach that is location-specific and involves intensive community engagement to identify objectives and priorities and to develop strategies. This means that technical solutions must be modular and culturally acceptable if they are to promote holistic neighbourhood development in existing informal settlements. The solutions must also be in line with existing plans of municipal authorities and should be implemented in contexts where no existing sanitation solutions exist.

In contrast to other projects that GIZ supports, in ISUD it is directly involved in technical delivery and awards contracts for site-specific designs through consulting local architects and WASH (water, sanitation and hygiene) experts before putting out tenders for construction. As

ISUD applies a learning model, GIZ selected pilot sites in towns with different conditions and needs. These four pilot sites are in three partner towns (Rehoboth, Opuwo and Helao Nafedi) and a secondary partner town (Marienthal), in areas representing one-third of the population of Namibia (<800 000 residents). Conditions at the selected pilot sites are very different. For instance, the site in Opuwo is an existing DWN site for waste collection. In Helao Nafedi, on the other hand, people were relocated and now have security of land tenure, but the area is currently exclusively residential and lacks both amenities and identity. GIZ's aim there is to support the local NGO, Shack Dwellers Federation of Namibia, with *in situ* upgrading of the neighbourhood, focusing on providing urban amenities and giving identity to the neighbourhood. This is indicative of how the work of different agencies overlaps and the catalytic role that GIZ plays, either by channelling funding and/or connecting funding bodies to local authorities, while gaining contextual experience that is funnelled into government structures through a cooperative learning model.

The main criticism levelled against the GIZ model from other projects where the sole focus is on delivering sanitation is that the model is too complex and context-specific, and that it would therefore be difficult to scale up. However, GIZ views its approach as only one component of a larger strategy for systemic change, pointing out that every year there is a shortfall of 30,000 plots, resulting in more informality, and that its approach is able to deliver an additional 10,000 plots, a significant systemic impact. The GIZ interviewees also cited urban considerations such as connectivity, mobility, intensity (density) and economic issues that are factored into their work, and pointed out that the main aim is capacity building within government structures.

#### 4. Discussion

In post-independence Namibia, political promises created expectations that all citizens would receive water-flush toilets connected to centralised sewage systems, despite the obvious fact that this was not financially or technically feasible. Even in cases where such systems were feasible, political interference in technical and operational matters hamstrung service delivery, as revealed in this study and reported in a broad body of literature [11] [14]. For instance, the growth of informal settlements in Namibia has been rapid, especially in the past 15 years. While the growth in urban sprawl may be small in absolute terms, it represents a substantial change relative to the total population. In fact, shacks in informal settlements are projected to be the predominant form of housing in Namibia by 2025 [7]. Communities in such settlements are often unconnected to municipal services, such as water and sanitation, because of bureaucratic barriers resulting from land tenure and practical constraints of infrastructure since Namibia is one of the least densely populated countries in the world. These constraints make decentralised, on-site sanitation systems particularly relevant and attractive in the context.

In the previous section, we described the historical changes in sanitation delivery strategies for urban informal settlements in Namibia, based on interviews with two NGOs (Clay House Project and DWN) and an international development agency (GIZ). While sharing similar motivations and overall goals, the three organisations have different underlying philosophies and their own unique approach to sanitation delivery. DWN and GIZ continue to operate, while the Clay House Project is no longer active.

However, hundreds of the Otji-toilets built by the Clay House Project team are still in use across Namibia and have been replicated in other countries, including Ecuador and Nicaragua [20]. The Otji-toilet addressed the reality that municipalities were unable to deliver centralised sewage systems, which created a major bottleneck to unlocking land for housing delivery. The Clay House Project team recognised the potential of communities to organise and provide labour for self-built construction of low-cost, dry toilets. The team adapted waterless toilets to the hot, arid climate of Namibia, and introduced innovative

designs such as a new urine-diverting toilet bowl that reduced liquid build-up in pits. In the long term, however, this did not meet with the approval of authorities and led to political resistance. This is partly due to the fact that toilets could not work properly since innovations utilising urine separation were cut short by political rejection resulting in the persistence of odours and lack of user acceptance (e.g. malodour was a major issue), but mostly it seemed to be because municipalities wanted to emulate the sewage systems of economically developed countries.

In contrast, more recent efforts by DWN and GIZ have sought to address structural, managerial and behavioural issues alongside the technological and economic concerns. DWN's solution, a water-flush toilet or dry pit latrine (depending on the context), is arguably less innovative and relies on trucks to empty pits and septic tanks. However, the advantage is that these solutions do not require direct handling of excreta, which is in line with the hygiene and health-related impetus that gave rise to the DWN project, as opposed to concern for housing which was at the heart of the Clay House Project. DWN works directly with various partners, particularly UNICEF, and applies the international guidelines developed by UNICEF and WHO for constructing pit latrines, which opens the way for buy-in from municipalities and authorities. The DWN focus is not on developing construction-related economies, but rather on addressing health-related concerns (e.g. preventing future hepatitis E virus outbreaks) through education. For example, it has produced training manuals, information booklets and children's story books to target a diversity of readers on topics including urban sanitation, early childhood development and housing.

GIZ takes an even more systemic approach by working at multiple scales and in multiple sectors simultaneously. Its focus is structural and policy change and integrated development of urban informal settlements, and not simply delivering sanitation, which it views as part of a larger strategy. GIZ acts as a catalyst by promoting dialogue, collaboration and flow of knowledge and funding between different sectors, government and communities. Through its work, it has clearly illustrated that capacity building and community mobilisation are critical in addressing issues surrounding delivery of services like water and sanitation. However, projects such as ISUD that take a long-term perspective on development have not been attempted previously in Namibia and it will likely take a long time before tangible improvements emerge and on-ground realities for communities at informal settlements change. This is also one reason to consider the sanitation delivery models of other organisations, despite their narrower focus.

The Clay House Project responded to an urgent need for delivering housing and sanitation in post-independence Namibia, while DWN responded to an urgent need to build toilets and raise awareness on hygiene in informal settlements struggling to manage outbreaks of waterborne diseases. It could be argued that the short-term success achieved by NGOs like DWN and Clay House Project is crucial for the long-term success of international development agencies like GIZ that are aiming for systemic changes in urban governance.

Overall, we found that none of the organisations and none of the sanitation delivery models that they have developed to date have systematically considered managing and reusing the excreta collected in pits and toilets. The Otji-toilets are serviced by private enterprises that remove excreta and are paid by the municipality for the service. However, the collected excreta is not considered a resource that could be utilised by the community, while urine diversion was introduced solely for the purpose of reducing the moisture content. Similarly, pit latrines and septic tanks built by residents following the model provided by DWN are emptied by private service providers paid by residents. They also do not consider urine as a potential resource as the focus is on delivering sanitation systems that meet technical requirements of municipalities, either by using familiar technologies like septic tanks, or by drawing on the international guidelines set out by UNICEF and WHO for the adoption of dry pit latrines. In both cases, excreta are transported for further treatment at municipal sewage treatment plants. GIZ's projects, which are currently still in the planning stage, are working to integrate

water and sanitation infrastructure, such as toilets, with other urban functions like green spaces and recreation. According to schematics provided by the technical team, GIZ is considering urine diversion as a technical solution, where urine is directly drained to soil and used for urban farming purposes. Experience from large sanitation programmes, such as China's Toilet Revolution, clearly shows that it is important to develop service chains that safely collect, treat and reuse excreta (e.g. for use as fertiliser or for bioenergy production), and do not simply provide people with access to toilets [20,22].

All three organisations interviewed were receptive to the idea of source separation of human urine as a possible technical solution, because recycling urine could generate supplementary income that would partly offset the cost of servicing toilets. In fact, the *Otji-toilet* is an example of what could have been with regard to urine diversion in Namibia. In Otjiwarongo's informal settlements, the Clay House Project team had a community in urgent need of sanitation, but was also open to incrementally integrating technical solutions over time (e.g. solar drying). In Gobabis, the team introduced innovations like toilets that separated urine from faeces using surface tension. The reasons why the urine-diverting *Otji-toilet* did not become more popular were probably that the technology was not sufficiently mature and that the knowledge base on urine collection, mitigation of malodour and treatment of urine was generally insufficient at that time [23]. For example, toilets based on a working principle similar to the *Otji-toilet* [24], but with a different bowl design, are commercially available today, such as the Save! toilet [25]. Technologies that safely convert source-separated urine to solid fertiliser with high nutrient content (>15 % nitrogen on a dry matter basis) are also advancing rapidly [25,27], and have been validated in different settings [28]. Such innovations have the potential to address multiple sustainability challenges [29], which is in line with the ambition of projects like ISUD. Implementing them in practice could help urban informal settlements move away from the "gold standard" of sanitation – an outdated paradigm involving flush toilets, sewers and centralised treatment plants releasing nutrient-rich effluent that causes eutrophication and pollutes water recipients.

## 5. Conclusions

Delivering sanitation in urban informal settlements is one of the greatest development challenges globally, considering that nearly a billion people already live in such informal settings and that the rate of urbanisation and urban informality is rising. This study evaluated work by NGOs and international development agencies, either alone or in cooperation with local authorities, to bridge the sanitation gap in informal settlements in Namibia. The analysis showed that the organisations have different motivations and philosophies, resulting in them creating different models for sanitation delivery. As a result, they also occupy different niches within the informal settlement sanitation space in Namibia. For example, Clay House Project and DWN responded to the urgent need of communities for housing and diseases prevention, whereas GIZ is working to create system-level changes to urban development planning and governance.

Each model has its pros and cons, as critically evaluated in this study, with implications for other organisations working in informal settlements elsewhere. For instance, the Namibian case shows that a diversity of complementary sanitation delivery models is needed, with some focusing on achieving short-term goals while others address structural concerns playing out over longer time spans.

However, management and reuse of source-separated urine and faecal sludge were not fully considered in the different models developed by the organisation studied. This is unfortunate, because safely recovering and valorising nutrients, water and energy from excreta could have environmental and financial benefits for incremental sanitation delivery in informal settlements. However, based on an official perception that freeborn Namibians cannot be expected to handle human excreta, it is possible that practices such as recycling of human

urine as fertiliser may face political resistance or will be rejected by communities. Future studies are needed to determine whether this would indeed be the case, and to identify strategies that could help introduce new innovative solutions in decentralised on-site sanitation in informal settlements.

## CRediT authorship contribution statement

**Gert van der Merwe:** Conceptualization, Methodology, Investigation, Software, Data curation, Formal analysis, Writing – original draft.  
**Prithvi Simha:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Funding acquisition, Resources, Supervision, Project administration.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data will be made available on request.

## Acknowledgements

The study was supported by funding from the Swedish University of Agricultural Sciences for the project WATERSIDE - Hybrid Living Lab for Water and Sanitation in Arid Regions (Grant Number SLU.ua.2022.4.1-405). Prithvi Simha was supported by funding from the Swedish Research Council Vetenskapsrådet for the project NECESSITY (Nästa generationers källsorterande avloppssystem) (Grant number 2022-04188).

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