

Article

Disposable Diaper Usage and Disposal Practices in Samora Machel Township, South Africa

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Abstract: Single-use disposable diapers have a major impact on climate change due to greenhouse gas emissions from landfills, especially those that are unlined, and particularly when such diapers are not well-managed and dumped in water courses and open spaces or burnt. The aim of this study was to explore the current usage and disposal practices of disposable diaper users in Samora Machel, a township in Cape Town, South Africa. The findings were to be used to inform the design and implementation of a pilot diaper collection model to follow. This urban/peri-urban area comprises lower-income, high-density communities in formal basic housing, with many backyarders and informal shacks. The dumping of diapers in open spaces and sewage systems causes severe problems. Therefore, we employed a theoretical socio-ecological system approach to guide the understanding of these complex environmental issues; the data collection methodology entailed a community-based participatory study process. Four hundred and eight (408) questionnaires consisting of quantitative and qualitative answers were codeveloped with members of the community and completed by trained community-based fieldworkers. A community walkabout and two focus groups provided rich data. The results show that complex waste streams such as disposable diapers and the related environmental issues are testing the limits of current management approaches; managing disposable diapers in underserved low-income communities creates a major burden for these already fragile communities. Single solutions will not suffice for these complex problems, so innovative waste management systems need to be codesigned with communities and relevant stakeholders to ensure sustainability, equality, and social justice.

Keywords: sustainability; sustainable development goals; disposable diapers; South Africa; absorbent hygiene products; waste management systems; socio-ecological systems; community-based participatory research; backyard dwellers



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1. Introduction

Absorbent hygiene products (AHPs), such as baby diapers, incontinence products, sanitary pads, and personal care wipes, have become essential products for ensuring accessible and convenient personal hygiene in daily life [1]. However, these AHPs are also some of the main contributors to microplastic waste [2,3]. AHPs are complex products consisting of several materials, such as nonwoven plastic materials that provide waterproofing, wood fibers that attract water, super-absorbent polymers (SAPs) that retain and hold moisture, and plastic tabs to secure the AHP in place. As a result of these components, the products are difficult to manage at the household level if no waste management services are available. The inappropriate management of disposable diapers poses serious environmental and health threats [4,5]. A single diaper requires 250–500 years to degrade [1]. Cabrera and Garcia [6] estimated that, in Europe, 33 billion single-use diapers are generated annually, of which over 80% are landfilled. Ng et al. [7] summarized the conclusions of different life

cycle assessments conducted on disposable and reusable (cloth) diapers. Ng et al. [7] and Hoffmann et al. [8] concluded that disposable diaper systems have a large environmental impact mainly due to the generation of solid waste, whereas the main impacts of reusable cloth diapers are derived from washing. A meta-analysis of LCA studies conducted by the United Nations Environmental Programme (UNEP) in 2021 found that single-use disposable diapers have the highest impact on climate change arising from greenhouse gas emissions from landfills [3], particularly if the landfills are unlined [4]. UNEP [3] and Cabrera and Garcia [6] highlighted that no LCA studies have focused on determining the impact of mismanaged diaper waste, for example, where the waste is dumped in water courses and open spaces or burnt. In a newly published study by Schenck et al. [5], who focused on a rural area with no waste management, diapers were burnt and dumped in open spaces and water courses. The findings showed that the most notable impacts from disposable diapers were those contributing to human and ecological toxicity, mainly due to their improper disposal.

The South African Department of Forestry, Fisheries, and Environment (DFFE) [4] estimated that approximately 700,000 tonnes of diapers and other similar AHP waste is generated and disposed annually into landfills in South Africa. According to 2021 statistics, the major challenge is that only 60.3% of all households in South Africa had weekly refuse removal services [9]. More than one-third (35.1%) of households had to rely on communal or household refuse dumps, whereas 1.6% of households had no facilities at all. Godfrey et al. [10], Schenck et al. [11], Kalina et al. [12], and Rodseth et al. [13] have ascribed the waste mismanagement performance of municipalities in South Africa to failures in governance and organizational weaknesses, inappropriate service delivery, and aspects such as corruption. Regrettably, little has changed over the years [9], so waste management services will probably continue to deteriorate [10–13]. To complicate matters, a major factor that is overlooked in waste management services delivery statistics is the backyard dwellers, or tenant population, who mainly reside in the townships of South Africa [14–16] and are not adequately serviced by municipalities. Backyarding is seen as a fairly new type of land use and the fastest-growing housing type in South Africa [15]. Backyarding refers to a situation where a formal homeowner rents a portion of their yard to occupants of a dwelling constructed mostly by informal methods. This provides income to the property owner and accommodation predominantly to jobseekers from rural areas and migrants from neighboring provinces and countries [14]. More people are estimated to be living in backyard structures than in informal settlements in South Africa [15]. Municipalities generally only deliver waste management services to formal homeowners as they pay the rates. Backyard dwellers are thus responsible for managing their own waste [11,14–16] and dependent on the homeowner, whether they might use the waste facility provided by the municipality.

This lack of adequate and appropriate service delivery results in waste, including AHPs, being dumped, burned, and buried [14–17]. All these practices have negative impacts on the environment, human and animal health [3,5,7,8,17,18]. According to Rodseth et al. [13] and Sepadi [18], with limited waste collection systems available, AHP waste often ends up in open spaces and water courses and is disposed of in toilets, thus blocking sewage systems and leading to burst mains and effluent spillage in streets and rivers.

Sepadi [18] highlighted that the health of poorer communities is being attacked “at all corners”, as it is difficult for poorer communities to protect themselves given their insufficient access to basic services [10,17–19].

In the South African context, limited research has been conducted on the usage and disposal practices of AHPs and, in particular, on disposable diapers in the lower-income households in a high prevalence of backyarders and informal housing context. Studies have been conducted in rural areas by Sepadi [18], the Itumeleng youth project [17], Kordecki et al. [2], and Schenck et al. [11], and Schenck et al. [3]. In this study, we aimed to explore the usage and disposal practices in the Samora Machel township in Cape Town, South

Africa, a low-income area, in order to understand how users manage complex AHPs amidst insufficient service delivery and challenging living conditions.

1.1. Study Area

The Samora Machel township in Philippi, Cape Town, is an urban/peri-urban area comprising lower-income, high-density communities that have basic formal housing with many backyard dwellers and informal settlements using shack-type housing. According to Mkentane [20] and Phaliso [21] less than half of the residents reside in formal houses and serious concerns have been raised about the contribution of backyard dwellings to overcrowding and increasing densities beyond the capacity of the installed infrastructure, which includes waste management services [22]. Managing the disposal of used diapers and other AHPs seems to be problematic for the residents of Samora Machel, as these items have been found dumped in open spaces and water courses (Figure 1).

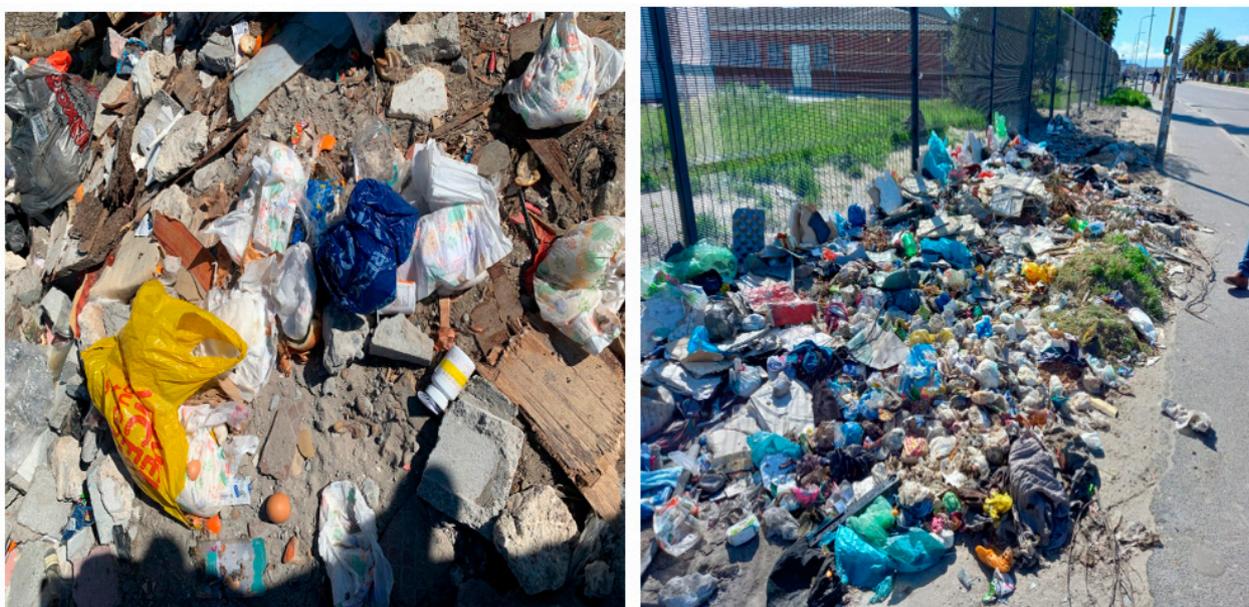


Figure 1. Dumped disposable diapers in the Samora Machel township (source: the authors).

The population of the Samora Machel township (hereafter Samora Machel) has exponentially grown due to increased urbanization and an influx from rural areas, particularly the Eastern Cape Province of South Africa. Brick buildings coexist with informal structures built using sheet metal or other makeshift materials. Access to sanitation, water, and electricity is problematic [20,23]. Weekly waste management is only provided to formal households, which are provided with a black wheelie bin. The backyarders are excluded from this service. Waste dumped in undesignated spaces such as on roadsides and open areas is illegal in South Africa, so it is referred to as illegal dumping. It is intermittently collected by contractors who use workers from the Expanded Public Works Programme (EPWP). The EPWP is a government-led program that provides poverty and income relief by providing temporary work for the unemployed to perform socially useful activities.

The prominence of AHP waste in urban and rural areas where it cannot be responsibly disposed of is increasing in South Africa. The DFFE has put out a tender to develop a strategy, which states that “pilot projects should help to lay a foundation for the drafting of the strategy to identify potential policy instruments and action plans that could help the country to address AHP waste effectively”.

Understanding residents’ diaper usage and disposable practices in low-income and informal areas with backyard dwellers will contribute to effectively addressing AHP waste in the South African context.

1.2. Theoretical Approach

In the field of environmental management, the socio-ecological system (SES) approach or framework can assist in dealing with complex environmental issues [24–27] as it uses methods from social, economic, political, and ecological sciences. The SES embraces complex environmental problems with multiple “learning by doing” solutions (instead of top-down ready-made single solutions), including all relevant stakeholders [25]. According to Virapongse et al. [25], urgent environmental issues are testing the limits of current management approaches and demand innovative approaches that integrate traditional disciplinary boundaries. Virapongse et al. [25] explained that the SES framework is built on the following concepts:

- A systemic worldview requires that systems are observed as a whole with all their elements connected and in interaction with each other. Relevant to this study, Virapongse et al. [25] argued that to build a systemic worldview of the issue at hand, we must understand the system, which can only be achieved via engagement with all stakeholders using platforms such as focus groups, interviews, and workshops.
- Transdisciplinary approaches enable the codevelopment of new and rich knowledge and processes when a diverse group of experts and stakeholders is involved. Transdisciplinarity has the potential to create multiple perspectives and possible solutions relative to complex environmental problems.
- Codevelopment of knowledge implies that researchers should move away from being experts to be “one of the many actors within a system that contributes to the learning and knowledge generation process” [25].
- Adaptive governance has theoretical foundations in the field of participatory approaches. Participatory approaches in particular focus on self-mobilization, creating a shared vision, resolving conflict, and building capacity toward a bottom-up self-organizing process [11,24–27].
- Virapongse et al. [25] emphasized that SESs should be built on appropriate, solid data collection, monitoring systems and management between all parties involved. This includes data collection by researchers and the use of citizen science and participatory research practices with community members.
- Education, training, and capacity building are integral parts and continuous processes of the SES process for all involved. They include using systems thinking and SES approaches in the management of environmental issues and embracing the knowledge, belief systems, and practices of all stakeholders.

2. Materials and Methods

Based on the theoretical SES approach and concepts, we performed a case study using a community-based participatory research (CBPR) process to develop a pilot disposable diaper collection and management system, as requested by the funder of the study project. CBPR is a research approach that refers to research activities conducted in local settings in which community members actively collaborate with professionally trained researchers. Importantly, researchers, stakeholders, and community members collaborate as equals in the research process [28,29]. In CBPR, the community is regarded as the co-owner of the research, which builds on local solutions and social innovations to solve complex issues and promote democracy [28].

We (a social worker, chemical engineer, and communication specialist (authors 1 to 3, respectively)) collaborated with a co-design expert (author 4), who worked closely with a well-established, respected nongovernmental organization (NGO), Ubunthubethu (meaning “our humanity”), within Samora Machel. Via the NGO, a meeting was organized with key community members (including the Ward Councillor) to explain the aim and objectives of the project and negotiate entrance to the community (Figure 2).



Figure 2. Introducing the planned project to the community and gaining access (source: the authors).

We collaboratively decided that a formal research questionnaire and focus groups would be developed to gather information to understand the current usage and disposable practices regarding disposable diapers within the community before the last (third) phase, the codesign process (not discussed in this article), for collections to commence. In this article, we therefore only discuss the results of Phases 1 and 2 of the CBPR process.

2.1. Research Phases

2.1.1. Phase 1—Quantitative Study: Questionnaire

An already-designed questionnaire developed for baseline studies exploring disposable diaper use in rural communities [5] was introduced to the core group of community members. The questionnaire contained 60 questions exploring biographical data, buying preferences and patterns, and usage and disposal practices. The questionnaire was collectively accepted and adapted to fit the purpose of the study in Samora Machel. A WhatsApp group was established between the four researchers and the core community members to collaboratively manage the research process, answer questions that might be unclear, and make observations during the research study. Photos of illegally dumped diaper sites could also be sent.

On 6 August 2022, five selected community members from Samora Machel were trained to conduct the data collection. The interviews, which involve sampling mothers or caregivers looking after babies who are still using diapers, were conducted from 8 August to 27 September 2022. Caregivers from both formal homes and backyard structures were included in the sample. Two of the community members monitored the data collection process of the fieldworkers. The data collection team was also supported by the second author for the quality control of the completion of questionnaires. In total, 408 questionnaires were completed, cleaned, and captured in Microsoft Excel.

2.1.2. Phase 2: Qualitative Phase

Qualitative data collection consisted of the following:

- The questionnaires used in Phase 1 contained a few explanatory qualitative questions, which provided valuable explanatory data.
- Observations were recorded during the community walkabout (transect walk) conducted on 30 August 2022, during which members of the community research team walked through parts of Samora Machel to observe dumping sites (Figure 1) and the state of the township's sanitation facilities (Figure 3).
- In addition, two focus group discussions were facilitated: the first on 13 September 2022 at the Masibambane Community Centre (Figure 4) and the second on 1 October 2022 at Sondela B&B in Samora Machel. The focus group discussions were held on Saturdays to create opportunities for both working and nonworking mothers to participate.



Figure 3. Observations of blocked drains during the community/transect walk (source: the authors).



Figure 4. Focus group discussion participatory mapping (source: the authors).

Both focus groups began with a participatory mapping exercise (Figure 5), followed by questions asked to explore the area's current waste system and the current management and disposal of diapers. The groups were requested to draw a map of Samora Machel and indicate where diapers are dumped (Figure 5). The mapping exercise, which also served as an icebreaker, generated active interaction and rich data.

The majority of respondents (47.7%) indicated that they were unemployed, 24.8% had some form of part-time or contract work, and 9.6% were self-employed. Only 17.9% of participating women indicated that they were employed full-time.

The employment status of the heads of households was higher than that of the mothers, with 32.5% employed and 33.8% unemployed. Of the participants, 24.3% indicated employment in contract and part-time work, whereas 7.8% were self-employed. Retirees (retirees were grandfathers or grandmothers who were seen as heads of the household) accounted for 1.6% of the total. In line with the South African unemployment rate, which was 33.9% in the second quarter of 2022 [30] and 32.9% in the third quarter of 2022 (the time of the research study) [31], only 32.5% of household heads were permanently employed.

3.1.2. Social Security Grants

South Africa has an extensive social security system with a range of grants available for children, the elderly, persons with disabilities, and war veterans. Given the high unemployment and poverty rates in Samora Machel, 81.9% of the respondents confirmed that they receive one or more grants in their household, with 1.7 grants on average. The results from a similar study in a rural area in South Africa by Schenck et al. [5] showed that 97% of households were grant-dependent. Madisa and Amashabal [32] reported that 18 million South Africans were dependent on the grants issued by the South African Social Security Agency (SASSA), such as child support and old age pensions. Another one million recipients were added when the ZAR 350 social relief and distress grant was issued during the COVID-19 pandemic. This means that 30 million, or half of South Africa's population, are grant-dependent [32].

3.1.3. Diaper Use and Disposal Practices

All respondents indicated that they were using disposable diapers, and none made use of cloth diapers. The reasons are described later in this article. The respondents were requested to provide the estimated number of diapers used per day per baby. On average, 3.58 diapers were used per day, with a range of 1 to 8, depending on the age and health of the baby. The older the baby, the fewer the diapers used, but if they were sick (e.g., with diarrhea), more diapers were used. Among the 408 households \times 1.3 babies per household \times 3.58 diapers used per day, result in the generation of 1899 diapers generated and disposed daily by the respondents. Kim and Kim [33] found that caregivers used 5.6 diapers on average in Scotland. A table provided by Kim and Kim [33] showed how the number of diapers used per day declined as babies aged, starting at 8.7 per day when the baby was between 0 and 3 months old, and decreased to 2.3 per day when the baby was 30 months of age.

For the question regarding how diapers were disposed of, various reasons, as indicated in Figure 6, were provided (more than one answer could be chosen).

The vast majority of interviewees (347) indicated that they disposed of diapers in the dustbin or municipal bags, which are taken to the landfill. Ninety (90) reported using the skip bin provided by the CCT in the community, whereas sixty-eight (68) disposed of diapers in toilets: pit latrines, flush toilets, or communal toilets. A total of 65 mentioned that they dumped used diapers next to the road, and 22 replied that they dumped them in the open veld and riverbeds. Under "Other", some respondents said they disposed of used diapers in blue plastic bags provided by the CCT, and some buried used diapers by digging a hole. Notably, during the focus groups, we mentioned that even if they disposed of diapers in the bins provided by the CCT, the contents of the bins would be dumped if the bins were full or not collected.

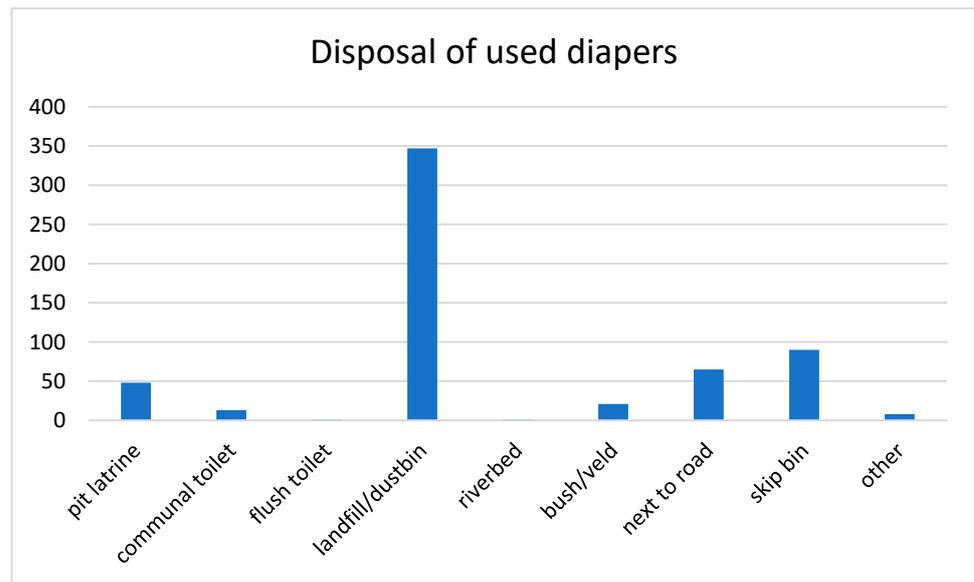


Figure 6. Methods of used diaper disposal (source: research data).

3.1.4. Willingness to Separate Diapers from General Waste

To be able to codesign and implement a collection system for used diapers, the households should be willing to separate such diapers from the rest of their household waste. Mothers were asked to describe their willingness to separate used diapers from general waste. Of the 403 respondents who answered the question, a slight majority (52%) of respondents said that they were not willing to separate diapers from the rest of the household waste, whereas 48% indicated willingness (Figure 7).

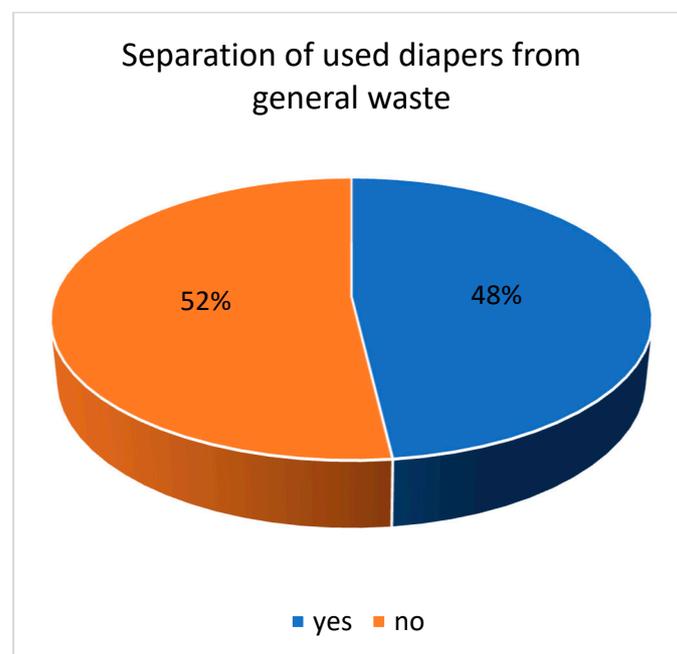


Figure 7. Willingness to separate used diapers from household waste (source: research data).

We did not explore the reasons for respondents' unwillingness, but in later discussions, a reason emerged: It might be because the respondents did not have space and/or containers to manage the separation. During the Phase 3 codesign process, some mothers shared that concerns about separating the diapers are linked to superstitious beliefs that

the babies' feces could be used to put a spell on the baby and the family. This was also confirmed by Schenck et al. [5]. The questionnaire did not provide context to the question, and perhaps they did not realize why it should be separated. In the next section of the study, a greater willingness was expressed.

3.1.5. Taking Diapers to a Central Place

Although 52% of respondents indicated that they were not willing to separate used diapers from the rest of their household waste, 94% were willing to deliver separated diapers to a central point in the community (Figure 8). Caregivers were willing to separate the diapers from the rest of the household waste if places or containers were provided for their delivery. Taking them to a central point would offer a solution so they would not have to store the diapers. More important is that a communal receptor anonymizes the baby's diapers.

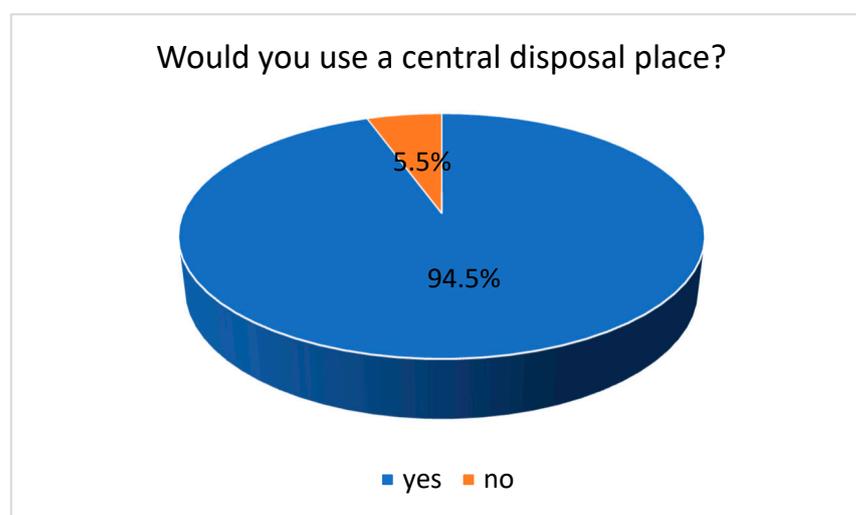


Figure 8. Willingness to use a central disposable system (source: research data).

3.1.6. Buying Patterns and Preferences Regarding Disposable Diapers

In the question relating to where participants buy diapers, they could select more than one option.

As shown in Figure 9, two major South African retail shops, Shoprite and Clicks, were where diapers were bought. Under "Other", a list of 13 other shops were mentioned, including well-known retail stores such as Woolworths, PEP, Checkers, Dis-Chem, and Ackermans, as well as some unknown shops, which may also be spaza shops (South African slang for a small shop in a township. <https://www.collinsdictionary.com/dictionary/english/spaza-shop>, accessed on 5 March 2023).

We further explored the disposable diaper brand preference. Respondents could indicate more than one preference.

Disposable diapers are colloquially referred to as "brand name" (the brand names have been anonymized regardless of what brand is used). We found that the two most popular brands are made by two of the major global manufacturers. Various lesser-known brands were also mentioned. The respondents indicated that they buy their preferred brand at the beginning of the month when they receive their grant or income. Later in the month when the caregiver needs more diapers, a cheaper option would be bought at local shops: for example, the spaza shops in Samora Machel.

As most of the mothers were unemployed and grant-dependent, we wanted to know how much they spent on disposable diapers per month (Table 1).

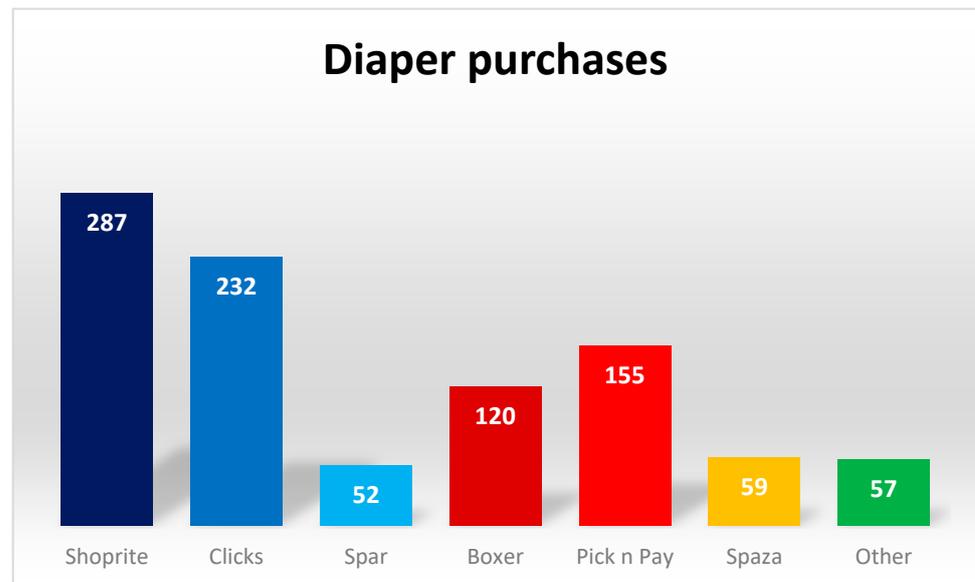


Figure 9. Shops where diapers are purchased (source: research data).

Table 1. Amount spent on diapers per month (ZAR).

Average	Mean	Standard Deviation
436.59	420.00	173.99

Source: Research data.

On average, the respondents or households said they spent ZAR 436.59 monthly on diapers. As most mothers (81.9%) received grants, this means that almost the total amount of the SASSA child support grant was spent on diapers, which, at the time of the study, was ZAR 480 per month per child. Comments provided during focus groups clarified this point. The respondents mentioned that the father of the child and grandparents often supported them when they needed to buy diapers. This matter was discussed further in the qualitative section.

3.2. Qualitative Results

From the qualitative answers in the questionnaire, the themes identified were as follows:

Theme 1: Reasons for preferring disposable diapers;

Theme 2: Perceptions about the impact of disposable diapers on people and the environment;

Theme 3: Hindrances to waste and diaper management in Samora Machel township.

3.2.1. Theme 1: Reasons for Preferring Disposable Diapers

Customers do not always make purchasing decisions based on environmental performance or the cost of products [34,35]. Plotka-Wasylika et al. [1] and Kim and Kim [33] highlighted convenience, comfort, and cost-effectiveness as reasons for using diapers and that disposable diapers have become indispensable in everyday life. In a study by Matsobane [22] on the Mashashane village in the Limpopo Province of South Africa, the reasons given for using disposable diapers were convenience, ease of use, affordability, a lack of water to wash cloth diapers. From the open-ended questions posed in the questionnaire on why participants prefer to use disposable diapers, the following similar reasons were given:

Reason 1: Cloth diapers are old-fashioned and not visible in the shops.

A reason given was that cloth diapers are seen as “old-fashioned”, are not used “in this generation”, and are not very visible in shops: “I don’t see cloth diapers anymore”.

One participant explained that although she wanted to use cloth diapers, she “never saw them although she wanted them”.

It further seemed as if peer pressure exists as a social norm: Participants commented that cloth diapers are “out of fashion and people will laugh at me”. In addition, during focus group discussions, a statement was made that if cloth diapers are used, this is a sign that the father of the child is not supporting the care of the child and is, therefore, an embarrassment for the mother/caregiver. They perceive the use of cloth diapers as a sign of poverty, as it is an indication that the mother is unable to pay for disposable diapers even if they spend all their child support grant income on the diapers (Table 1). However, the next theme seemingly contradicts this view, as disposables were reported to be seen as the cheaper and more affordable option.

Reason 2: Disposable diapers are the cheaper option and save time, electricity, soap, and water.

In the UNEP [3] report, cloth diapers are promoted as being more environmentally friendly, but that cloth diapers is acknowledged to require water, soap, and energy, which are not necessarily accessible, available, and affordable. In contrast to what we had assumed, participants viewed disposable diapers as the “cheaper” option. Upon deeper exploration, the cheaper option does not refer to the price of the diaper but to the fact that disposable diapers save time, and to use them, no purchases are needed for electricity, water, or soap. As the participants in the study were predominantly unemployed, they viewed disposable diapers as the cheaper option “because (it) saves time. No need (for) energy to wash and don’t even need water”. Additionally, “Washing and drying baby’s reusable diapers takes time, energy, electricity, cost, and effort”. After being purchased, no further costs are involved.

Reason 3: Disposable diapers are best for the health and comfort of the child.

Participants perceived that disposable diapers “are good for children”; they are “for good health of my child”. When referring to the health of the baby, participants mainly mentioned that disposable diapers prevent skin rashes: “. . . because of the skin and if (I) use cloth diapers, her skin rashes”. In addition, disposable diapers are viewed as providing comfort to the baby: “. . . good for the baby; there is softness and comfort the baby”; “diapers do not need to be changed very often”.

Reason 4: Disposable diapers are convenient for the caregiver of the child.

The convenience factor of disposable diapers has been cited in most research studies [2,3,5,17,18]. Similarly, in this study, many answers referred to the convenience factor for the caregiver. Disposable diapers are particularly convenient and easier to use if the caregiver has a disability or illness: “I don’t have to wash and I also have a disabled hand”. Another added “I have arthritis”.

In general, disposable diapers are seen as more convenient and “very easy and quick to use”. They “make things easy because I have twins”. Participants were also of the opinion that cloth diapers have to be changed more often while using disposable diapers “makes it quick and easy to change a child”. One respondent said: “I hate washing. Easy to use”.

Some frankly stated that they are too “lazy to wash every day”. It was also stated was that cloth diapers are not used because they have to be washed, “which I don’t want to”. In addition, due to the wet winters in Cape Town, cloth diapers are slow to dry: “It is winter and I do not have to wash”.

Reason 5: Disposable diapers prevent the need to handle stool.

Following the convenience factor of disposal diapers, mothers shared that disposable diapers prevent dealing with stool: “Disgusted by stool, to wash it”. One participant asked, “Who’s going to wash them? My laundry is enough—washing stool is a no-no”.

3.2.2. Theme 2: Perceptions about the Impact of Disposable Diapers on People and the Environment

Despite diapers being dumped, participants were aware of how disposable diapers may affect people and the environment.

Impact 1: Discarded diapers result in blocked drains and sewage in the streets.

The participants commented: “There are lots of streets that have blocked drains because of nappy waste”; “When the rain comes, diapers will run to the drains, then the drains blocks. There is sewage all over because of diapers too”. The following link, as reported by Mkentane [20], confirms the extent of the blocked drains in Samora Machel: <https://www.iol.co.za/capetimes/news/blocked-drains-disrupt-learning-in-samora-machel-as-toilets-spill-c73dd4cb-8575-47ce-bda6-d7d0b2e7bcd0>, accessed on 30 April 2023.

Impact 2: Discarded disposable diapers affect the image of the community.

With regard to dumped disposable diapers and sewage spilling in the streets, the participants were of the opinion that blocked drains, sewage spills, and discarded diapers affect the image of the community: “Other people [do] not want to visit [Samora Machel]”; “It affect[s] the image of community”.

Impact 3: Disposed diapers affect the environment.

Participants were aware of the effect of disposed diapers on the environment. Concerns were expressed that the dumped diapers “kill the environment”, “make the environment dirty”, and “pollute the environment”. One commented: “It is not smelling nice [as] dogs throw it (the diapers) around”.

Impact 4: Impact on community and child health.

Participants felt that a dirty and smelly environment affects the health of the community, particularly that of children: “When we breathe, we breathe dirty air”; “Other kids be playing around that nappy, not knowing and they be having diseases”; “[Diapers] pollute the water that we drink”.

3.2.3. Theme 3: Hindrances to Waste and Diaper Management in Samora Machel Township

The barriers to waste and, in particular, to diaper management were highlighted in the questionnaires and during discussions in the focus groups.

Hindrance 1: Dumping occurs due to the limited space available to store diapers in their living environment.

In both groups, certain open spaces were identified as regular dumping locations: “people are dumping because of the open spaces and unused spaces since there is no space in the back yard, so they can easily go there and dump”. Another comment was as follows: “Then there is Tsurha [name of a place in Samora Machel]. Tsurha is very big, it has its own big yard, then there is that dumping place next to the police station”. The open space next to the Spar retail shop that was burnt down a few years ago (in 2020, the community burnt down the Spar shop as part of a protest action) was also identified, as well as a spot between Samora Machel and the main road: “The wall between the Samora and the main road was broken down . . . According to the law, no one is supposed to walk there, that is why there is a fence, no one will be accounting for why people are throwing things there”. While drawing the map, one participant instructed the following: “Draw the old age home and the dumping place . . . As you go next to the dam there is a drain that is blocked—it must be visible—that’s where we stay”. Although most respondents indicated that they dispose of their diapers in the bins that are sent to the landfill, they actively acknowledged dumping diapers in the “designated” places for dumping. These reactions regarding some of the dumping places showed that dumping is not indiscriminate but has become a regular practice at certain places over time. Living in shacks, either informal areas or as backyarders, results in having limited space for the storage of diapers. Accepted open spaces provides a management “solution”.

Hindrance 2: Stray dogs spread disposable diapers.

When we visited Samora Machel, stray dogs roaming the streets were visible. Dogs were also identified by both groups as one of the major reasons for used diapers in the

streets. If a bin is put out at night, “the big one yes, the dog stands up like this [on its hind legs] and the bin falls then that will invite other dogs so a lot of dogs will go to that bin”. “It is a problem because in our communities we don’t take care of the dogs; we don’t even give them special food . . . but”, she added, “we are changing that culture”.

Another person commented: “Dogs come and fetch the plastic, or they come inside the plastic and take the diapers out . . . Yes, the dogs come at night they are fighting at night about the plastics. Some of the bins don’t have lids, others don’t have the dustbins, so the dogs come and fetch the diapers from there”.

A suggestion was that “it would be best if people can empty the diapers before putting them out and flush it to avoid the dogs from running away with it, but what will happen if the toilets are not flushing? Even my toilet is not flushing as we speak”. Due to the blocked drains, flushing the contents of diapers is not a possibility.

Hindrance 3: Insufficient and inappropriate infrastructure and waste management services.

The lack of sufficient, appropriate infrastructure was emphasized as one of the major barriers with regard to waste management in general and, particularly, for diapers. The municipality provides a single bin free to homeowners on formal property. However, nearly every formal house has many backyarders. These backyarder families receive no bins or bags, which prevents them from participating in the refuse removal service. Consequently, their refuse is left on the side of the road or dropped at an illegal dumpsite in an open area or street corner.

Other groups of people identified as experiencing problems with insufficient waste management services were those living in apartments or flats with too few bins for the number of apartments. This results in overflowing bins. With regard to full bins, the common practice involves paying someone to empty the bin: “Can you see I am making an example: you bought a carpet then I remove the old carpet and throw it in the bin with diapers . . . then [I] ask William to fetch it and dump the waste somewhere and give him R10 to go and throw that away. Then he goes and dump next to Tsurha or next to old age home. Now he is not only dumping the carpet but the diapers as well”.

Schenck et al. [11], Tshangana [36] and Salvia et al. [37] have highlighted the misalignment between the needs in the communities and what is being delivered. In Samora Machel, as a lower-income community, regular weekly waste management services are clearly insufficient, as they do not have the means to manage their bulky and excess waste at drop-off sites or the space to keep it until collection day. An example was given: “I am complaining about the truck that only comes once—it has to come twice or three times in a week to come and fetch the bins”.

Hindrance 4: Blocked drains.

Another infrastructural challenge was the issue of blocked drains, in particular in the first focus group. Figure 10 is a photograph of this problem. Drains are often blocked because diapers and other objects are dumped in toilets. When participants were asked to indicate where they dispose of their diapers, a few shared that they dispose “to the drains”: “If you come to Samora, you will see that every drain is blocked now. They wanted to call a truck for us, but they said if they did it was not going to help because it will end up flooding this way”. It was clarified that the drains were blocked throughout Samora Machel, preventing the use of the toilets to dispose the stool in diapers. Blocked drains imply that the residents must also use open spaces for defecation.

Hindrance 5: Corruption and crime.

In their literature review on the drivers of illegal dumping, Niyobuhungiro and Schenck [38] described the link between crime, drug use, socially disorganized communities, and illegal dumping. The participants in this study agreed that a major challenge faced by Samora Machel is corruption and the prevalence of criminal activities, which hamper the delivery of services. As an example, they cited an incident in 2021 where a city official was shot dead while delivering a service to the community [39]. As a result, municipal officials are reluctant to deliver services to the community. This situation was explained as follows: “You know one thing about Samora, it is corrupt . . . sometimes we have a drain

blockage, the truck from the municipality they don't want to come and drain the sewage. They need to be escorted and we as the community we are scared . . . Even the (leadership) committees are scared". At the time of the writing this article, Phaliso [21] reported another incident where a city official was shot dead during waste removal. Phaliso [21] also shared that 183 murders were committed in Samora Machel in the past year. The participants also referred to several more murders in Samora Machel, which have hindered effective service delivery. An anecdote was shared regarding the operation of the gangs in these areas: "The other thing that has changed is that the 'skollies' (gangsters) back in the days they only had knives then you will scream then everyone will come out carrying a broom or a mop and beat the 'skollie,' but now they have guns . . .".



Figure 10. Blocked drains in the Samora Machel township (source: research data).

Participants further explained that criminal and gangster activities are worsened by the presence of drug users who offer to dump waste on behalf of households to earn money and steal bins to sell: "Because some of the boys are on drugs, they just want something to smoke, they have a new thing now—they will steal the bins and sell them for ZAR 10 or 20 (between USD 0.50 and 1)".

Hindrance 6: Lack of care and respect for each other and the environment.

Following the discussion on crime and corruption, the participants in this study ascribed the dumping of diapers in Samora Machel to a lack of care and respect for each other in the community: "You know what, it is even hard to tell someone [that] we do not have respect for each other anymore, because if someone feels like dumping in the road, they just dump. You can dump on the road, no one will ask why you are dumping. I don't know how we can manage the dumping because there are people from the City of Cape Town who come and clean. It doesn't matter if it is five minutes after they clean, someone will come and dump. No one will say anything".

It was further explained that confronting the dumping by drug users is difficult and they "do what they please": "They can stab you; they can fight you or go to your house and threaten you. So, everybody is looking after themselves".

Another reason provided for not questioning the dumping was that "people throw it at night. There are very few people that are throwing stuff during the day".

4. Discussion and Conclusions

In this CBPR case study, our aim was to explore disposable diaper use and disposal practices in Samora Machel township. During the study, 408 questionnaires with quantitative and qualitative answers were completed, observations were recorded in a community walkabout, and two focus groups were facilitated. The results showed that, in line with global trends, disposable diapers have become increasingly popular due to their convenience and fashionable factor as well as being seen as the cheap option, not incurring additional expenses such as soap, water, and electricity. Coupled with residents, particularly backyard- and shack dwellers, having limited infrastructural services and limited access to water and electricity, the feasibility of returning to reusable options is limited. The most popular brands are predominantly purchased from well-known retail stores: Shoprite and Clicks. Diapers are paid for by the father of the child and government child support grants. Due to limited space to keep used diapers, they are disposed in bins, which are dumped in open spaces. The increase in disposable diaper usage has placed additional pressure on an already stretched waste management system.

In line with the findings reported by Schenck et al. [11], we argue that the dumping taking place in Samora Machel is not indiscriminate. The results of the mapping exercise (Figure 5), the walkabout, and the focus groups showed that certain designated dumping spots exist in the community. Dumping has become a form of waste management and a perceived job creation opportunity in the community. According to focus group participants, even if the dumping spot is cleaned, people continue dumping in that spot. This indicates that its function has changed: These areas are now designated dumps. Repeatedly cleaning the dump was also seen by the participants as creating job opportunities for the unemployed [12].

A literature review by Niyobuhungiro and Schenck [38] revealed that insufficient waste services and social disorganization influence dumping, as also identified in this study. Community members specifically mentioned a lack of respect or social cohesion amongst the inhabitants of Samora Machel. This problem is compounded by corruption and criminality, which plague the community (at the time of writing the article, the research team also had to move out of Samora Machel due to the incidents mentioned earlier). Crime has also led to strained relationships with the CCT in terms of service delivery [39].

The results highlight the complex SES or socioeconomic environmental and political system of Samora Machel, which are rooted in historical and current policies and events. The Samora Machel case study provides an indication of the complexity of managing disposable diapers. Single solutions will clearly not suffice. The development of collection and management systems will have to be codesigned with the community and all relevant stakeholders if the Sustainable Development Goals of sustainability, equality, and social justice are to be at the heart of the process. The durability of diapers; the belief systems, perceptions, preferences, and practices of users; community socioeconomic, political, and environmental dynamics; and service delivery require an engaged, and collaborative change process [11,40]. Complexity, a changing context, systemic thinking, and transdisciplinary approaches [22] will need to be embraced. Virapongse et al. [25] saw the value of an SES approach to environmental management as developing “a new culture for science”, where researchers cross bridges and create a supportive context and framework for sharing knowledge and collectively searching for solutions.

This study confirms the point made by Kalina [41] and Velis et al. [42] that the global challenge of waste management is inherently linked to a city’s socioeconomic development. If cities aspire to improve waste management, they should identify methods to overcome the complex systemic underlying failures, which, according to Kalina [41], are inherent inequalities in the South African landscape. He argued that inequality should take center stage within our waste discourse: “we must continuously, and meaningfully, engage with the systemic socio-economic and socio-political conditions that created, and continue to create, our waste problems” [41].

In line with the SES approach, Schenck et al. [11], Kirsten and Fourie [43], Muheirwe et al. [44], and Salvia et al. [37] have promoted the developmental role municipalities should play to solve South Africa's complex development problems. They argue that municipalities should not try to solve them in isolation but work in tandem with communities, civil society organizations, academics, the private sector, and different spheres of government.

Skilled participatory researchers and practitioners are needed to facilitate transdisciplinary research, and collaborative practices to develop appropriate and effective waste reduction and disposal systems [40].

This study contributes to knowledge as our findings increase the understanding of complex disposable diaper waste issues and their management in low-income and under- and unserved socially disorganized communities in South Africa and probably Africa from the perspective of the community. We further illustrate the complex nature of waste management in general and disposable waste management, which demands a holistic, system-based approach.

The study was limited to one particular extremely difficult area in Cape Town, South Africa. The aim was not to generalize the findings but to understand the dynamics within communities from the viewpoint of the residents, such as Samora Machel. Future studies could focus on including the perspective of other stakeholders, the phenomenon of backyard dwellers and waste management, and the lack of agency or civic responsibility in taking action toward cleaner environments.

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