More toilet infrastructures do not nullify open defecation: a perspective from squatter settlements in megacity Mumbai

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Abstract

Sanitation problems faced by the humanity are tightly coupled with the ever-growing water problems. Better sanitation infrastructures ensure sustainable solutions to the health and water issues faced by the majority of the urban population on the planet. In this study, we investigated sanitation status for squatter settlements in Mumbai, a major global megacity. We observe that capacity building in terms of adequate toilet infrastructure alone cannot eliminate open defecation. There is a huge need for more toilet blocks in Mumbai's wards, even after considering unusable public and community toilets into account, since 71–99% out of 8417 toilets are not in good condition. We contend that the normal perception regarding more toilet infrastructures and its alleviating effect on open defecation is not always directly correlated and is an emerging as well as a complex urban issue. We corroborate the need for addressing associated governance issues along with capacity building, which will help stakeholders to identify the prevailing sanitation scenario towards further policy amendments. Further, effectively identifying the trends and processes entangled in the urban sanitation issues can ensure a more sustainable resource utilization situation and a better standard of living for the urban poor.

Keywords Sanitation · Toilet · Open defecation · Squatter · Governance · Assessment

Introduction

Sanitation

Poor sanitation practices by residents are one of the main causes of surface water pollution (Sharma et al. 2012). Inadequate sanitation coupled with unsafe drinking water claims millions of lives each year via enteric pathogen exposure causing diseases like cholera, dysentery, and typhoid (Selvam et al. 2017). Sanitation relates to public health, especially the provision of adequate and safe sewage disposal facilities of human excreta, i.e. faeces and urine. Though sanitation broadly includes four major infrastructures (excreta management, waste water management, solid waste

management and drainage system), it is strongly associated with excreta management system only, which is the subject of this paper. Billions experience a dearth of improved sanitation the world over, and millions defecate in the open, i.e. one in every 8 people (WHO and UNICEF 2015). The sanitation target of the recently concluded millennium development goal (MDG) fell short, which triggered United Nations to set a new target sustainable development goal (SDG) 6.2, i.e. eradicate open defecation by 2030 (WHO-UNICEF 2017).

Swachh Bharat (Clean India) Mission (SBM) and doubtful claims

Along with various global initiatives, a lot of efforts have been taken recently through SBM by the Government of India since October 2014. The revised guidelines of SBM-Urban described the process for declaring a city open defecation free (ODF) (MoUD-GoI 2017a). One of the key criteria is to have at least one community toilet in every 500 m. However, it assumed to provide only 20% of open defecators with community or shared basis toilet due to space constraints and targets the rest 80% to provide individual

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households (MoUD-GoI 2017a). The toilet coverage is updated on a real-time basis on the SBM dashboard (MoUD-GoI 2017b) where many cities claimed themselves as ODF to show that they have met the targets under the SBM banner. But the truth remains doubtful due the counter-claims raised by different organizations. For example, Mumbai was claimed as ODF first time on December 2016 by BMC (Brihanmumbai Municipal Corporation) or MCGM (Municipal Corporation of Greater Mumbai) (Bose 2016). Later, a team of SBM and QCI (Quality Control of India) exposed BMC's claim (Singh 2017). The blame game again rose up, as the State Government challenged BMC's claim (Phadke 2017).

Perspective

Previous studies have shown how toilet scarcity can lead not only to open defecation (Desai et al. 2015), but also to a stressful and time-consuming life (Bapat and Agarwal 2003). However, it may not be correct to assume that adequate toilet infrastructure can eliminate open defecation, especially when researchers assert the need for 'sanitation programs tailored for specific communities to meet the local demand' (Okurut and Charles 2014). Researchers also pointed out the need of critical input of academia which can help in achieving SDG (Tortajada and Biswas 2018). Keeping the extremely ambitious WASH targets (SDG 6.2) (Hutton 2016) in mind, we intend to investigate Mumbai's sanitation status to find out if adequate toilet structures alone can eradicate open defecation.

Objective

The objective of this study is to find out whether just building more toilets can eliminate open defecation or not? If not, why and what else is needed?

Approach

Study area

Mumbai is our study area that represents a megacity in a low or lower-middle income developing country. It is the capital of Indian state of Maharashtra and the financial capital of India. It is the highest populated Indian city. About half out of total 18.4 million people live in informal settlements (i.e. 13% of total space) (Biswas et al. 2018). Mumbai has 24 wards. Like other Indian megacities, it has many informal settlements pockets, presumed to be the reason for open defecation. Further narrowing it down (based on experts' recommendation), we conducted field visits at Machhimar Colony, Baiganwadi, Shivajinagar, Nirankarnagar, Ramabainagar, Behrampada and Jarimeri. Various experts from

academic and governing bodies are interviewed to finalize these places. These places are spread over the island city as well as in suburban areas and signify a wide variety of archetypal Indian informal settlements.

Data and method

Most researchers have chosen a survey for sanitation assessment in Mumbai (Karn and Harada 2002; Sharma and Bhide 2005), since stakeholder analysis is a useful tool to assess societal impact (Caniato et al. 2014). We carried out our sanitation assessment in three steps—assessing present sanitation scenario through secondary data analysis, estimation of toilet deficiency and field observations.

Assessing sanitation status

The first part of our study analyses the available secondary data of 8417 public and community toilet blocks of entire Mumbai, which is collected from Mumbai Metropolitan Region Development Authority (MMRDA). Apart from this, population data are collected from census 2011. The data are prepared with several wardwise parameters (toilet seat count, toilet block count, toilet condition, waste generation, area and population of informal settlements) that are used to demonstrate the position of a particular ward in terms of sanitation. These are population per toilet seat, area per toilet block, percentage of toilets which are not in good condition and per-capita per-day solid waste generation. These calculated parameters are put together and plotted later in Fig. 1 by using an open source web tool for visualization (RAWGraphs 2013). It is important to note that one toilet block may consist of one or many toilet seats (the average is 10 toilet seats per toilet block). So population is calculated per toilet seat, but the area covered is calculated per toilet block, as all the toilet seats of a single toilet block denote one toilet location.

Estimation of toilet deficiency

After scrutinizing SBM guidelines (MoUD-GoI 2017a), it is clear that the government targets elimination of open defecation with an assumption by providing 80% toilets to individual households and 20% on shared basis due to space constraints. It also focuses to place one toilet in every 500 m (MoUD-GoI 2017a). Thus, we came up with the condition of road length and population, for our estimation of toilet deficiency. However, road length is important dimension, so that a person finds a nearest toilet within few minutes during emergency. And population is important dimension, so that the toilet remains available for use. For road length, the shape file of the road map is converted from World Geodetic System (WGS) to projected coordinate system (PCS) to get

Fig. 1 Wardwise sanitation status in Mumbai

the road lengths. Later, the Mumbai shape files are clipped with each ward's boundary to get ward-level shape file with their road lengths. Thus, toilet demand is calculated considering the need of one toilet block in every 500 metres of road length. To calculate the demand from the population point of view, again the Swachh Bharat (Clean India) Mission (SBM) guideline (MoUD-GoI 2017a) is considered. Though the government provisioned for one-fifth as shared toilets (as discussed above), we considered the worst-case scenario for our toilet estimation, i.e. only shared or community toilet is to be provided, since it is the only solution to counter space scarcity in informal settlements (Evans et al. 2017). Apart from this, an extra 5% of total population is to be considered for public toilets (MoUD-GoI 2017a). For community toilets, there should be one toilet seat per 35 males and one per 25 females (MoUD-GoI 2017a). And in case of public toilets, there should be one toilet seat for every 250 males and one for every 100 females (MoUD-GoI 2017a). Taking all these into considerations, we get a toilet block demand

per ward. Now, we have existing toilet numbers, as well as demand. By subtracting, we derive the toilet deficiency for each ward as per road length as well as population demand (Fig. 2).

Field observations

Here we assess ground reality to show its association with official data. As per experts, there are several places in Mumbai, which are defecation prone. Those are Machhimar Colony of A ward, Baiganwadi, Nirankarnagar, Shivajinagar, Ramabainagar of ME ward, Behrampada of HE ward, Jarimeri of L ward and Chaitanyanagar from S ward. These places are recommended and chosen for our field visits, since we are supposed to get not only the extreme/worst conditions, but may be able to experience the best possible solutions for those types of conditions in practice. The government officials wish to be anonymous. After fixing the study area, an open-ended question was asked during the field visit, which

Fig. 2 **a** Toilet blocks required as per road length, **b** toilet seats required as per population in Mumbai (wardwise), considering SBM guidelines

we had decided from experts' opinion. The question was 'Do you use public toilets? If yes, then what are the difficulties you face?' Sometimes this question was extended further based on the situation to get maximum information. For example—'Do you ever think of open defecation? Or have you seen anyone defecating in the open? What do you think are the reasons behind open defecation?' However, we mostly concluded the facts based on our observations in these informal settlements.

Results and discussion

Sanitation status

There are two major assumptions in this analysis, i.e. the toilet locations and populations are considered uniformly distributed over the wards and the whole population of informal settlements uses the public and community toilets' facility. In Fig. 1, each bubble denotes a ward. The x-axis denotes the area covered by a toilet block, and the y-axis denotes

the population per toilet seat. If the toilet locations are not considered as uniformly distributed over the wards, then area covered by all the toilets in a ward would be different. Alongside its uniform distribution, if the total population of all the informal settlements in a ward are not considered as the users of public and community toilets (due to data limitation), then the users per toilet seat in a ward would be different. The toilet locations are considered uniformly distributed over the wards, and the whole population of informal settlements uses the public and community toilets' facility. The colour of the wards denotes the percentage of toilets which are not in good condition for a particular ward. In our secondary data, we already got the toilet information labelled as good, moderate and bad. Darker colour represents higher percentage of toilets not in good condition. The size of a bubble denotes per-capita per-day waste generation for any particular ward. Bigger the size means higher the per-capita per-day waste generation.

The point (0.00, 0) from which the x and y axes (Fig. 1) are originating is called 'origin'. The wards towards the origin are better as compared to the others, in terms of more

toilet numbers and lesser crowd per toilet, but those may not be in good condition. For instance L ward is good in terms of toilet density or area coverage by a toilet block, but 99% of its toilets are not in good condition (Table 1). Even ward D is best in toilet condition, but still has 71% toilets not in good condition. Figure 1 shows the overall scenario—where to focus more on toilet building or on maintenance. Since 71–99% toilet blocks are not in good condition (Table 1), mostly it is natural for slum people to choose open defecation over toilet use. The data analysis also tells us which ward needs to reduce its waste generation (Fig. 1).

Toilet deficiency

Considering a scenario of having one toilet block in every 500 metres road length, there are 8 wards which do not meet this criterion (Fig. 2a) led by South Mumbai (A, B, C, D, E) wards and KW ward. Ward A requires the highest number of toilet blocks, and the requirement is more than 2 times or 200% of the existing toilets. Whereas KW ward also needs the highest number of toilet blocks but its requirement is 92% more as compared to the existing. On the other hand, B and C wards need lesser number of

toilet blocks (around 50 numbers), but still it is around 1.5 times or 150% of what it currently has. But during our field visits, we observed that an informal settlement of 10,000 population may come under an area of 500 metres radius. Thus, the viability of having one toilet in each 500 m is itself a question. This also shows the need to consider population distribution while projecting the toilet demand. The toilet seats requirement as per population is also calculated. There is a huge demand for toilet seats (up to 11,234) over the various wards (Fig. 2b). Wards L and S need highest number of toilet seats (> 10,000). The toilet demand is huge even though we are not considering the provision of individual household toilets. But out of 24 wards, 14 wards require more than 100% toilet seats as compared to what it currently has. Out of those, wards RS and PS require 2 + times (> 200%) more toilet seats, whereas wards E and FN require 3 + times (> 300%) more toilet seats. Both the aspects of the toilet demand (road length and population based) need to be fulfilled in order to claim for open defecation. But what makes the situation even worse for wards L and Ward FN is having demand for huge number of toilets, even after taking account of 99% existing toilets which are not in good condition (Table 1).

Table 1 Wardwise toilet count with its condition

Wards	Toilet seat count	Toilet block count	Toilet block count as per their condition			% of Toilet blocks, not in good condition
			Good	Moderate	Bad	
A	889	94	16	74	4	83
B	291	40	8	30	2	80
C	215	35	3	31	1	91
D	694	91	26	59	6	71
E	629	78	14	58	6	82
F/N	2616	201	3	197	1	99
F/S	1502	135	1	134	0	99
G/N	3241	239	17	215	7	93
G/S	943	110	2	94	14	98
H/E	4334	357	3	279	75	99
H/W	1778	173	2	19	32	99
K/E	7272	791	68	680	43	91
K/W	2271	215	16	187	12	93
L	6306	778	4	707	67	99
M/E	7371	429	49	336	44	89
M/W	2962	217	22	171	24	90
N	5807	524	14	496	14	97
P/N	9805	1268	203	906	159	84
P/S	2903	335	79	241	15	76
R/C	2133	254	22	217	15	91
R/N	3167	399	26	318	55	93
R/S	4352	395	9	373	13	98
S	7238	1043	108	889	46	90
T	2157	216	45	142	29	79

Ground reality from field observations

This section helps us understand the ground reality, i.e. why capacity building alone might not eradicate open defecation.

Insights from Colaba (Ward A)

Machimar colony is the biggest informal settlement of Colaba in ward A. There are about four toilet premises, i.e. a total of 24 male toilet seats and 24 female toilet seats for the entire 10,000+ population. It is natural that people defecate in the open by force and not by choice. They choose the seashore instead of standing hours in the queue. This portion of seawater almost turns black (Fig. 3a). The alarming concentration of coliforms and nitrate are obvious in such open defecation-prone area (Adeola Fashae et al. 2019; Selvam et al. 2017). Women face more problems than men because of safety concerns, which leads them to defecate in plastic bags inside their home while neglecting health hazards, and then, they disburse the waste here and there or throw it into a dustbin. All the major stakeholders blames each other.

Insights from Govandi (Ward ME)

Baiganwadi and Shivajinagar areas of Govandi in ME ward are divided into small rectangular plots by the small lanes. In the centre of every plot, government organizations such as BMC/MHADA (Maharashtra Housing and Area Development Authority) had built toilet blocks. Each toilet block has 16–20 toilet seats, of which half are for

female and the rest are for male. Even though having the same toilet structure, there is a huge difference observed in different toilets. Toilets are found well maintained (Fig. 3b) wherever CBO (community-based organization), NGOs (non-governmental organizations) and local people work together. They have fixed one/two people among themselves to take care of operation and maintenance of a toilet, by paying INR 20–30 per family per month. Some of the toilet blocks charge people on usage like INR 1–2 for local-block people. They sometimes allow outsiders by charging higher such as INR 3–5 per person. BMC/MHADA handover the toilet to the local people through CBOs formation, which brings a sense of ownership that plays a key role in overall maintenance. In many cases, the plot-people often distribute toilet seats of their toilet block among themselves and lock them so that no outsiders can avail this facility. Thus, it becomes personalized toilet seat for 5–10 families.

On the other hand, lack of public participation is the main reason for the poor toilet conditions (Fig. 3c, d). In those cases, we see no water connectivity, no CBO and no caretaker. People sometimes bring water and sometimes not. Maintenance people come once or twice a week or month, depending on the call from block people, which renders the toilets filthy and stinky with piled-up excreta. Most toilets have a septic tank mechanism, and only a few of them are connected to a main sewer line. Hence, a better planning and design is crucial for onsite sanitation since a present investigation shows that the groundwater gets more contaminated in hard rock setting than alluvial (Quamar et al. 2017).

Fig. 3 **a** Seaside view of Machimar Colony at Colaba, **b** a good-conditioned toilet seat at Baiganwadi, **c** a poor condition urinal at Shivajinagar, **d** a stool overflowed toilet seat at Shivajinagar, **e** the leachate drain and the waste beside Deonar dumping ground wall with a whole

to commute for the purpose of open defecation, **f** an abandoned toilet block at Ramabainagar and **g** multi-tier poorly constructed houses beside the drain at Behrampada

Nirankarnagar is situated just beside the Deonar dumping ground wall. Because of toilet scarcity, most of the people here either have to stand in the long queue or hold their pressure until they reach Baiganwadi or Shivajinagar toilets. Many choose to defecate in the open. They make holes in the dumping ground wall (Fig. 3e) and defecate openly on the both sides of the wall. There is a leachate drain (Fig. 3e) parallel to the dumping ground wall, which is also full of waste plastic, excreta, etc. Females face more problems while defecating in the open because of lack of security especially during night time. So they have to hold their pressure to go to Baiganwadi toilets, or in case of any emergencies they use plastic bags in their home and throw them in the nearby dustbin or narrow lanes. It was very difficult to find free space to put feet while walking on these narrow lanes where excreta bags are scattered. People usually go to Shivajinagar for municipal water. Heavy flies from nearby dumping ground, leachate drain and filthy lanes pollute the drinking water buckets and force everyone to cover their face. It is a dangerous case of health hazard.

Ramabainagar of ME ward also follows the same trend of poor sanitation condition (Fig. 3f), though space is not a constraint here at all. Many waste sorters and rag pickers live here. Most of the toilets here have dilapidated septic tanks or aqua privy system which are connected to the nallah. An official along with one of the NGO informed about the rising toilet politics, i.e. local leaders want toilets to be built in low quality so that it get dilapidated easily and draws attention for rebuild over very less time duration. Local people defecate outside the toilet near a nallah and abandoned clogged toilets even though they are empty. People accused governing bodies and pointed out corrupt mentality, turf issues and unaccountability behind this poor show.

Insights from Behrampada (Ward HE)

Behrampada is situated at the east side of Bandra railway station under HE ward. Very poorly constructed multi-tier buildings make this place far more congested than the other settlements. There is a storm water drainage line parallel to main road. People have built their houses on both the sides of the drainage line. This drainage line is no longer able to carry liquid wastewater as it is totally blocked by solid and liquid wastes. Here, the cesspool vehicle can not even imagine entering because of such narrow lanes. So mostly the excreta is either stored in locally built septic tanks or directly goes to open storm water drainage that drain that can not flow away (Fig. 3g).

Insights from Jarimeri (Ward L)

Jarimeri of L ward is another example of a congested informal settlements. The condition of public toilets is also poor

as it lacks maintenance and cleanliness. Many people have made in-house toilets. Those who can not afford go to public toilets or defecate in Mithi River. Both type of toilets public and private have septic tanks, which is meaningless. Septic tank of inner area is connected with the small to medium sized nallahs, those join Mithi River (Fig. 4c). So the excreta or black-cum-grey water flows through Mithi River (Fig. 4d). The toilet seats are so poor at some places that people excrete outside the toilet seat (Fig. 4a). In many cases, doors are found broken, and there is also no light, no exhaust and no water. The good thing is some of the areas have water connections directly to their home. But the white pipes which carry water are often submerged in small drains (Fig. 4b), and pipes are found broken at some instances. So there is no guarantee that the water remains unpolluted in such conditions.

Insights from Powai (Ward S)

Chaitanyanagar of Powai is situated in S ward. Most of the Powai area is a developed where households have in-house toilets which are connected to main sewer line. However, the eastern part of Powai, i.e. Indiranagar and Chaitanyanagar is different from the rest. For example, there is one free public toilet block in Chaitanyanagar market area and the other one is paid toilet in Gokhalenagar Bhaji market. Those who can afford to pay go Gokhalenagar, but those who can not choose Chaitanyanagar toilet block, where there is no exhaust fan, no water, there are broken doors, dark conditions, no maintenance, clogged toilet pans due to liquor bottles and sanitary napkins (Fig. 4e). But it has two positive sides—it runs 24 h and there is no fee. So anyone can access these. People often do not bring water that affects its maintenance.

Conclusions and way forward

Highlights as sanitation status

In this study, a sanitation assessment is sketched out for squatter settlements of megacity Mumbai, with the help of a data-centric analysis followed by field observations. It revealed the deficiency level of toilet seat count among Mumbai's wards. Ward FN needs more than three times of toilets; however, wards S, L and RS are leading the tally of required number of toilets. But 71–99% of toilets are not in good condition which often leads citizens to choose open defecation over filthy toilets. Hence, it is not justifiable or correct to expect that having sufficient number of toilets can eradicate open defecation, unless we address associated governing issues.

Fig. 4 **a** People have excreted outside the toilet seat, **b** white pipes carrying drinking water, **c** black water from the toilet block comes out and flows through a small nallah, then big nallah or drain and finally

transfers waste water to Mithi River, **d** Mithi River carrying black-cum-grey water, at Jarimeri, **e** toilet condition at Chaitanyanagar market area at Powai

Findings from field observations

In association with lack of adequate toilets, our field observations identify several associated governance issues such as—lack of operation and maintenance, corrupt attitudes of governing authorities, negligence and mentality of stakeholders, inability of poor citizens in applying enough pressure to execute the policies and to assist governance, etc. The study also highlights success stories which involve the symbiotic participation of community-based organizations (CBOs), non-governmental organization (NGOs), government authorities and citizens for better operation, where a sense of toilet ownership for informal settlers plays a prominent role. Our study discloses the truth about the doubtful claims about ODF (as mentioned earlier), i.e. though the number of toilets may have increased over the time, but practicing open defecation is still being observed in Mumbai. Despite the well-known approach of handling, the increasing governance issues in sanitation is a worrying thing. There is another key issue which is out of the focus, i.e. where this excreta is going to land? One of the officials anonymously doubted that we do not have enough capacity to handle these enormous amount of human waste and everything is somehow contaminating the water bodies. Without solving these issues, it is not possible to become ODF in actual sense. There is a need of policy change in ODF tag both at national and global levels, which should incorporate an integrated governance framework along with capacity building, in order

to eradicate open defecation in proper sense. Otherwise, we may experience SDG 6.2 to fail in future. Are we going to wait 12 years till 2030?

Future scope

In short, we have identified the lacunae in sanitation status through a comprehensive assessment and established the need for an integrated governance framework. This study is helpful for researchers and decision makers, since they may follow the assessment procedure towards further policy amendments. Development of a time-framed governance framework integrated with ODF policy is the immediate challenge.

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Compliance with ethical standards

Conflict of interest The authors hereby declare that there is no conflict of interests regarding the publication of this article.

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