



A Case for Minimizing Human Interface for Sustainable Sewage Management in India

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ABSTRACT

The abstract text is mostly illegible due to low contrast and blurring. It appears to discuss the challenges of sewage management in India and the role of human interface in sustainable development.

Keywords: Waste management; Good governance; Health; Sustainable development; Urban

INTRODUCTION

India produces 62 billion liters of wastewater per day according to the Central Pollution Control Board (CPCB). In urban areas only about 45 percent of the dwellings are connected to an underground drainage system. Nearly 62.5 per cent of wastewater in urban India receives partial or no treatment. Sewer cleaning is the process of unblocking and cleaning sewer and wastewater drains. Sewage system plays an unequivocal role in our lives by protecting both our health and the environment. The main objective of the sewage system is to collect waste water and clean it before returning it to the environment. Sewage management is an integral

component of sustainable development incorporating within it, the aspects of health, water and environment management as well as urban governance. The social group of sewage workers is a striking illustration of the intertwined effects of industrialization, urbanization and poverty. Sewage workers lie at the bottom most rung of the social and economic ladder, are exposed to various types of exploitation from every quarter. Nevertheless, manual sewage cleaning that is detrimental to the health and life of the workers continues to flourish as it absorbs the migrant and unskilled workforce that is considered less suitable for obtaining work in the so called modern formal sector [1].

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LITERATURE REVIEW

Brief Historical Background

Observing the drainage system of Indus valley civilization, Ernest McKay quoted that, "It is certainly the most complete ancient system as yet discovered. Every house was connected to the street drains. House drains first emptied into a sump or cesspit into which solid matter settled while waste water flowed out into the street drains. Very long drainage channels were provided at intervals with sumps for cleaning. It is a wonder of archaeology that little heaps of material, mostly sand, have frequently been found lying alongside drainage channels, which shows that the debris was not always carted away when the drain was cleared". Babylonia was the first place to construct a drainage system around 5th century BCE. In the second century BCE, in Aegean civilization the knowledge of the hydraulics was evolved in the Island of Crete where sewers were large enough for peoples to walk through. Athens had a sewer system which delivered the storm water and human wastes to a collection basin which is outside of the town. In Rome the first sewers were constructed around 800 BCE where terra-cotta pipes were utilized. Irrefutable documentary evidence exists of the state employing manual scavengers during the regime of Mughal emperor Jahangir. In the 19th century, the urbanization of the industries and cities increasing populations led to proliferation of human waste. In the mid-19th century, a worldwide epidemic cholera occurred following which the British engineers developed the first modern day sewers that separated waste from drinking water [2].

Objective: This paper looks into the socio-economic aspects of manual sewage cleaning and analyse the prospects of reducing human interface in sewage management while highlighting the best practices and innovations to make it non-discriminatory and sustainable in the endeavour to achieve the related sustainable development goals and targets at the national level.

Sewage Workers in India

Manual scavenging is defined as 'the removal of human excrement from public streets and dry latrines, cleaning septic tanks, gutters and sewers'. It is the act of cleaning sewers or removal of waste from toilets without the use of safety equipment. This practice is still widely prevalent in India, driven not only by class and income divides, but much more by caste and patriarchy. Section 2(g) of the prohibition of employment as manual scavengers and their rehabilitation Act, 2013 defines manual scavenger as 'a person engaged or employed by an individual or a local authority or an agency or a contractor, for manually cleaning, carrying, disposing of, or otherwise handling in any manner, human excreta in an insanitary latrine or in an open drain or pit into which the human excreta from the insanitary latrines is disposed of, or on a railway track or in such other spaces or premises'. The definition of manual scavengers as per the prohibition of employment as manual scavengers and their rehabilitation

act, 2013 is narrow and excludes a wide variety of work done by diverse people, most importantly, drain cleaning. The government recognizes latrine cleaners, railway cleaners, sewer cleaners, waste treatment plant workers, drain cleaners, domestic workers, and faecal sludge handlers under a single amorphous category of 'manual scavengers' [3].

Manual scavengers and safai karmacharis are the two major types of sanitation workers recognized in India. However, both these terms are used fluidly, manual scavengers are individuals employed by a public body or private body or an individual for manually cleaning, carrying, disposing or handling in any manner, human excreta and safai karmacharis are sweepers or cleaning workers in municipalities, government offices or private offices. The Indian state does not officially recognize the employment of manual scavengers, almost all of whom are dalits. They are officially hired as cleaners who are contractual labourers. The department of social justice and empowerment does not maintain the statistics of such cleaners and thus, there is a conspicuous absence of reliable baseline data. Hence, while the ministry of social justice and employment directed to differentiate between manual scavengers and safai karmacharis, the prohibition of employment as manual scavengers and their rehabilitation act 2013 recognizes the workers involved in sewage cleaning within the category of manual scavengers. In addition, the government does not officially maintain any data on sewage workers, thus, excluding them from the politico-administrative mainstream and denying them a recognized and dignified standing [4].

Status: Sewage workers are not recognized separately by the Indian state. They are enumerated within the category of 'manual scavengers'. The Socio-Economic Caste Census (SECC) of 2011 identified 1,80,657 manual scavengers across the whole of India, whereas the safai karmachari association estimates that the numbers are closer to more than six times that number, at around 1.2 million (PIB 2017). It is estimated that there are around 1,53,000 sewer cleaners, all of them being men. Manual scavenging still survives in parts of India without proper sewage systems. It is thought to be most prevalent in Gujarat, Madhya Pradesh, Uttar Pradesh, and Rajasthan. The socio-economic caste census (2011) reported that Maharashtra had 63,713; Madhya Pradesh 23,093; Uttar Pradesh 17,619; Tripura 17,332; Karnataka 15,375 manual scavengers. However, the exact number of manual scavengers living in India is still largely unaccounted.

By observing the spatial distribution of manual scavengers, it is inferred that the number of such workers is higher in the states where the caste system is deeply rooted within the social structure, especially in the North Indian states of the Hindi Heartland, namely Madhya Pradesh, Uttar Pradesh, Rajasthan and Bihar. Notably, these states have also recorded a high population of the Scheduled Castes (SCs) as a part of their total population (Uttar Pradesh 20.7%, Rajasthan 17.8%, Bihar 15.9%, Madhya Pradesh 15.6%) as is also the case with Punjab that has the highest proportion of SC population in India at 31.9%. Karnataka (17.8%) and Maharashtra (15.6%) also have a significant population of the scheduled castes

along with a well-known history of caste struggle, documented through of Dr. B.R. Ambedkar and Mahatma Jyotiba Phule in Maharashtra and M.N. Srinivasan, G.S. Ghurye and Ramchandra Guha in Karnataka respectively (Figure 1) [5].

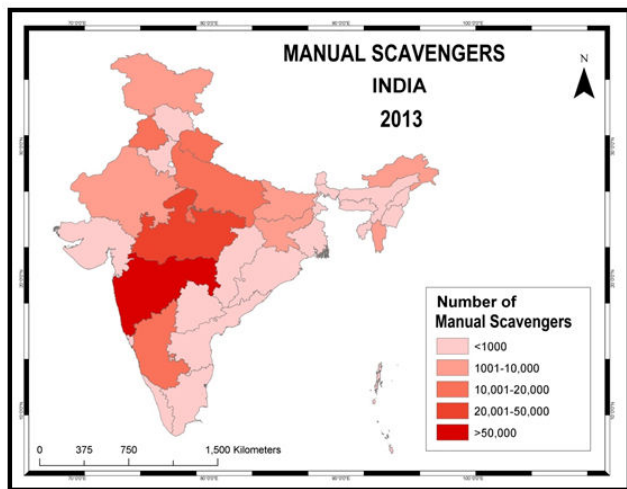


Figure 1: Spatial distribution of sanitation workers.

Deaths: The sewage water undergoes anaerobic decomposition, consequently emitting high amount of gaseous Hydrogen Sulphide (H_2S) and Methane (CH_4) that are toxic in nature. These gases asphyxiate the manual scavengers that enter the septic tank, causing their death. Other evident causes of their death are collapse of sewer structures, lack of safety gear and equipments, accidents, collisions, drowning etc. Machines, if deployed become obsolete to operate in very small sewer line and thus, such a situation leads to a Hobson's choice for sewage worker. As many as 801 sanitation workers have died while cleaning sewers in the country since 1993 according to the National Commission for Safai Karamcharis (NCSK), a statutory body set up by an act of parliament. When projected spatially, Tamil Nadu reported highest number of deaths (194 deaths) followed by Gujarat (122), Karnataka (68) and Uttar Pradesh (51) (PTI 2019). The highest death rate of 37% was recorded in the age group of 15-25 followed by 35% the age group of 25-35, thus, making the act of cleaning sewage a huge 'waste of the demographic window' available to India. 94% of the families of the deceased belong to the scheduled case category, 4% to the other backward classes and 2% to the scheduled tribe. The union Ministry of Social Justice and Empowerment (MoSJE) in a statement in parliament revealed that 282 sanitation workers died while cleaning sewers and septic tanks in the country between 2016 and November 2019 based on the number of FIRs filed by the police in the respective states. The Safai Karmachari Andolan, an NGO working for the welfare of manual scavengers and eradication of the practice of manual scavenging has estimated that 429 deaths occurred in Delhi alone from 2016 to 2018 and nearly 2,000 manual scavengers perished every year in the sewers, due to exposure to poisonous gases [6].

Problems: Despite rapid growth in urbanisation and technology, the working conditions of the sewage workers

have changed little since independence. The reality of sewage workers portrays the binaries created enroute development and the dichotomies of India's social structure and economic system, manifested in the divides of rural and urban, high castes and low castes, bourgeoisie and proletariat, oppressor and oppressed, purity and pollution, discrimination and equity, ascribed and achieved identities, and the gendered division of labour. As many as 2 percent of sewage workers have been estimated to die in the course of their work, because of the lack of protective equipment and minimal safety measures. Most of the workers who engage in sanitation work they mostly tend to migrate from rural areas. Deploying manual labour for cleaning sewage results due to the supply side conditions of the labour market than the demand of such labour under advanced capitalism. Malthusians and Neo-Malthusians attribute the excess labour supply to higher population growth [7].

The work of cleaning sewage directly leads to nausea, skin infections, anaemia, diarrhoea, vomiting, jaundice and trachoma as well as cardiovascular degeneration, musculoskeletal disorders, infections, skin diseases and respiratory ailments in sewage workers. They face various problems in accessing basic facilities like, electricity, water supply, and toilets. They do not get any training before they joined as a sanitation worker and are unable to avail medical facilities and financial assistance when they face serious health-related problems. They do not even have any health insurance facilities and any life insurance facilities. Most of the workers are recruited on contract and do not get the minimum wages. The minimum wage of sewage workers is mandated to be at Rs. 7000-8000 per month. The salary of Rs. 300 for a 12 hours day is modest, even by the standards of India's lower classes. Despite the life risks and the hazardous working environment, the average salary for the sewage cleaners is only about 260 rupees/day. Most of the worker do not use safety equipment because most of the time the contractors do not give any safety tools such as boot, mask, brooms, gloves, soap, disinfectants and uniform. Alcoholism prevalent among the sewage workers is mainly due to the service they are expected to provide by entering in the gutter which is difficult to perform while remaining in senses (national commission for safai karamcharis 2005-2006). India's bigger cities have large, centralized sewerage systems with vast underground pipelines, pumping stations and huge treatment plants. These systems are expensive to build and even more expensive to operate effectively, as they require continuous power, a large amount of water, skilled operators and extensive electro-mechanical maintenance. It is for this reason that more than India's 7,000 small towns do not have such systems and are unlikely to be covered by centralised sewerage systems in the near future and thus, the deployment of manual methods for sewage systems is expected to remain a glaring reality in the near future revealing the culpable fault-lines that define urban planning [8].

The Role of State

“In no country, people are sent to gas chambers to die,” remarked the supreme court of India in 2019 regarding manual scavenging in India. In India even as the sewerage workers have continued to die due to poisonous gas, the apathy and indifference of the state has continued. The employment of manual scavengers and construction of dry latrines (prohibition) Act, 1993 did not ban manual cleaning of sewage, but rather sought to regulate its conditions and furthermore it had no real provision for punishing those who did not comply. Under section 7(a) of the protection of civil rights act, 1955, forcing another person illegally to engage in bonded labour, manual scavenging or disposing animal carcasses is deemed to be a criminal offense. The prohibition of employment as manual scavengers and their rehabilitation act 2013 prohibits the employment of manual scavengers, the manual cleaning of sewers and septic tanks without protective equipment, and the construction of insanitary latrines. It seeks to rehabilitate manual scavengers and provide for their alternative employment. However, a controversial clause under the 2013 act is that if the sewage workers use protective equipments, they are then no longer classified as manual scavengers. The biggest problem that stands as a hurdle in addressing the problem of manual scavenging is that the government and other major institutions deny the existence of scavenging despite the deaths reported. By denying it, these institutions do not leave any question on solving the problem. Some of the worst offenders in perpetuating manual scavenging are not private contractors, but public agencies. Surprisingly, Indian railways are the largest employer of manual scavengers. The ministry has itself confessed that manual scavenging cannot be completely eradicated until stations get washable and sealed toilets systems. Additionally, not a single annual report of the National Crime Records Bureau (NCRB) has recorded any crime under the manual scavengers and construction of dry latrines (prohibition) act 1993 till today [9].

The explicit aims of the flagship Swachh Bharat Abhiyan (SBA) were fourfold: To eliminate open defecation, to eradicate manual scavenging, to bring in modern and scientific municipal solid waste management, and to effect behavioral change regarding healthy sanitation and sewage maintenance practices. Due to the undue emphasis on the first goal, critical areas of eradication of manual scavenging and rehabilitation of such workers, as well as the associated need to address solid waste management have been ignored. Lots of new toilets have been constructed, without any strategy about how they are to be cleared. They are seldom if ever linked to sewage, drainage and water facilities and solid waste management practices, and there has been little or no investment on procuring mechanized sludge and pump machines for physical removal of excreta. Neither the state nor the central governments have been mandated to provide financial assistance for the conversion of insanitary latrines which has adversely affected any positive tangible support to the manual scavengers. So, while cities after cities are pushing the envelope to emerge as the cleanest cities in the ongoing ‘swachh sarvekshan,’ the unending deaths of sanitation

workers still forced to carry out acts of manual scavenging and the lackadaisical approach towards their rehabilitation, are a blot on the entire swachh bharaat mission. Thus, at a policy level, the swachh bharaat abhiyan has addressed the issue of access to toilets, ignoring those cleaning them. The National Policy on Faecal Sludge and Septage Management (NPFSSM) 2017 acknowledged that acknowledges that even though the practice of manual scavenging has been banned by the law, but the social and cultural acceptance of such practice acts as a barrier for sewage management and that as part of the state level strategy, the operating procedures should include safety procedures with an emphasis on safety, health and dignity of sanitation workers (national policy on faecal sludge and septage management 2017). The deaths of workers while trying to keep sewer lines and septic tanks working, and the many ailments and diseases they suffer owing to the nature of the work are not cited once in the policy statements on sanitation. In Delhi’s projected sewerage master plan for 2031, according to a report by People’s Union for Democratic Rights (PUDR), there is clear acceptance that some sewers that exist can be (at present and in the future) cleaned only manually and spacing of manholes in these are made accordingly [10].

In safai karamchari andolan vs. union of India case in 2014, in which the supreme court ordered the abolition of the practice of manual scavenging and asked for the implementation of rehabilitation of such workers. However, even the evident judicial activism has been found wanting as courts have often failed to take suo motu cognisance of deaths of sewage workers and cases of compensation, criminal offences such as negligence have dragged on for years making justice inaccessible for the already marginalized workers. Activist Bezwada Wilson lamented on the inadequate role played by judiciary, “the court must explicitly say that we cannot allow human beings to enter into a sewer line at a time when we are sending people to the moon” [11].

Local governments have been subservient to middle-class interests, and informal sewage workers have not been able to organise into labour movements, there has been a weak sanitation movement in Indian cities. Most municipal agencies in India have opted for the public private partnership model of sewage management by outsourcing the exercise of sewage cleaning to private contractors who also handle the occupational safety aspects of the sewage workers. Contractors do not, generally belong from Dalit communities. Hence, in most cases, the ‘untouchability’ factor deters them in providing basic safety gears to sewage workers. Also, the ‘profit motive’ results in the ‘least cost approach’ of such private ventures, where safety equipments are not made available in absence of effective regulatory provisions [12].

While legal, environmental and technocratic aspects of sewage management have been subjected to extensive public debate, the social dimension of caste attached with it has been conveniently ignored. The notional aspects of ‘purity and pollution’ are imprinted upon the job of manual scavenging. The caste culture externalises the responsibility of maintaining cleanliness to particular castes. People belonging

to such castes falling in the lowest rungs of the caste system are relegated to sanitation-related jobs and are posed as the 'waste-absorbers' of the Indian society (SOPPECOM 2015). This caste ethos, effectively 'casteises' and genders various tasks, persists despite the spread of education, globalisation and urbanisation. While the world over people have imbibed a civic sense and primarily bear the responsibility to maintain cleanliness, only secondarily relying upon sanitary workers, in India, people derive a sense of superiority in littering, expecting it to be cleaned by the lower caste scavenger. The prime minister even equated the job of manual scavenging to a spiritual activity bestowed upon the valmiki community, a scheduled caste, by god, thus, emulating Mahatma Gandhi's approach of garbing the intricacies of the discriminatory caste system with religio-spiritual apparel, by creating ascriptive and patronising labels, that had received vehement criticism from. In the words of "In India, a man is not a scavenger because of his work. He is a scavenger because of his birth irrespective of the question of whether he does scavenging or not". Most of the manual scavengers in the country are Dalit, and even among different Dalit castes, such workers tend to be lower in the hierarchy, coming from some of the most marginalised and oppressed sub-castes. An independent survey of Safai Karamchari Andolan, an NGO for the elimination of manual scavenging revealed that 98 percent of manual scavengers in the state belonged to scheduled castes. They are forced to do this work under social pressure where it has continued as tradition and custom [13].

The scavenging castes are known by different names in different states like Bhangis, Balmiki, Chuhra, Mehtar, Mazhabi, Lal Begi, Halalkhor etc. in Northern India; Har, Hadi, Hela, Dom and Sanei etc. in Eastern India; Mukhiyar, Thoti, Chachati, Pakay, Relli etc. in Southern India; and Mehtar, Bhangias, Halalkhor, Ghasi, Olgana, Zadmalli, Barvashia, Metariya, Jamphoda and Mela etc. in Western and Central India. These communities face social distance as well exclusion in villages and cities as a part of their everyday existence. Consequently, the Dalit community has been excluded from a dignified right to life due to their forced retention in caste based and hereditary occupation. The people born in this community are considered agents of pollution due to their background of social hierarchy, based on birth. The appalling hardship, humiliation and exploitation they face, have no parallel in human history. Their vulnerability is exploited by the people as well as the state. Although modern sewer systems have come to represent legitimacy, sophistication, and moral citizenship but, its introduction has not eliminated the practice of manual scavenging. It has merely given it a new form as the role of 'Bhangis' changed from untouchable sweepers to sewer workers, which is equally oppressive. Sewerage cleaning demands a corporeal surrender that sweeping never did. It invades the body [14].

Minimizing Human Interface in Sewage Management

The genesis and the continuation of the practice of manual scavenging and cleaning of sewage has been due to concomitant combination of multiple factors functioning

simultaneously within the socio-economic structure and politico-administrative system in India. However, for achieving the sustainable development goal target 6.3 enumerated by India, 'By 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally', it is imperative that the direct interface of humans with sewage is replaced without the exclusion of the actors involved in the derogatory task [15].

RESULTS AND DISCUSSION

The upliftment of sewage workers by ending manual scavenging can be understood through four approaches: Gandhian approach, technocratic approach, legal approach, and rehabilitation approach. The Gandhian approach appeals to the conscience of the people, especially the oppressor, in accordance with the philosophy of 'Satyagraha' of Mahatma Gandhi, in order to bring about a change of heart so that the dignity of the individual is recognized and equality is instated. This approach also involves change of euphemisms, such as christening of the Dalits as 'harijans', and which the current disposition has followed actively by renaming manual scavengers as 'Safai Karmacharis' etc. When the 150th birth anniversary of Mahatma Gandhi has been celebrated globally, one is aptly reminded of his audacious statement, "I may not be born again and if it happens, I will like to be born in a family of scavengers so that I may relieve them of in human, unhealthy and hateful practice". However, observation of the present social reality makes it very clear that the Gandhian approach has been grossly ineffective as barring very few instances, the moral high ground and nominal changes in nomenclatures has failed to usher in any paradigmatic shift in the manner the caste system as well as the denigrating nature of scavenging work is perceived and adhered to. The technocratic approach, as a pall bearer of modernity seeks to replace the traditional system with modern methods by combining technological advancements with administrative initiatives such as replacing dry latrines with flush toilets, manual sewage cleaning with automated or robotic cleaning systems [16].

This approach requires strong political will to implement due to budgetary constraints and until the issue of manual sewage cleaning comes into the mainstream public domain, its success would remain doubtful. The legal approach is utilized by social activists, lawyers, judiciary and the lawmakers to deploy the strengths and benefits of the political, administrative, legislative and the judicial system to bring about end of the scourge of manual scavenging. The parliamentary acts against manual scavenging of 1993 and 2013, policies on sanitation (Swachh Bharat Abhiyan 2014), faecal sludge management (2017), supreme court judgments (2014, 2019), the creation of the National Commission for Safai Karmacharis (NCSK) are considerable efforts in this regard. However, experience has shown that mere legal measures yield little impact until deep-rooted structural reforms are brought in the socio-economic system. The

rehabilitation approach advocates for policy of rehabilitation of sewage workers by providing them alternative means of employment which is presumed, would end the practice of manual sewage cleaning. This approach seeks to fix the demand-side loopholes. However, given the voluminous population of India and the bane of jobless economic growth, this approach appears to be quasi-utopian and superficial in its methods [17].

To achieve the sustainability of sewage management, it is quintessential to adopt a three-pronged strategy, firstly, implementation of the SOPs (Standard Operation Procedures) for sewage cleaning in the short term (however, there is little conviction that given the scale of manual sewage cleaning operations, this would be a feasible solution) secondly, complete automation of the sewage cleaning process deploying robotic, artificial intelligence, Geographical Information System (GIS), Internet of Things (IoT) techniques (technocratic approach) and thirdly, simultaneous skilling and handholding of the current manual sewage workers so as to rehabilitate them into alternative jobs and entrepreneurial ventures (rehabilitation approach). Notably, the provisions in the 2013 act provide for financial assistance but they should be directed towards starting public toilets [18].

The problem of sewerage management must be addressed in a holistic manner, with a strategy that provides for minimum needs and is appropriate and affordable for all areas, considering the local situation. Invariably, there is the need of social transformation through generation of awareness and strict implementation of technology. The government proposal for amendment of the manual scavenging law aims at mandating the use of machines for cleaning sewers and septic tanks. It has stated that the word 'manhole' will be replaced with 'machine-hole' in all the official government documents. For the first strategy, the sewerage tank or drain must be sprayed with calcium carbonate, turmeric powder and cow dung mixture in all the directions possible. Project garima by Tata trust aims at providing safe, hiding and humane working conditions for the sanitation workers. For the second strategy, the NCSK has directed the state governments to provide sucking and jetting machines to the municipal committees for the cleaning of septic tanks but due to their inefficacy in clearing sludge in manholes, humans have to enter to clean that clog. The Greater Hyderabad Municipal Corporation (GHMC) has procured a manhole-cleaning robot called 'Bandicoot', which would help end the practice of manual scavenging. The key features of the machine include a complete robotic solution for eliminating manual scavenging and cleaning sewage in a world-class manner using four advanced sewer cameras which work in day and light [19].

Big sewage cleaning trucks may not be able to navigate narrow settlements but the robot can. Countries like Mexico have adopted the ecological sanitation model of collecting sewage as an agricultural resource after treating it and in countries like the United States of America, sewage maintenance system is fully automated. Creation of more employment is one of the most important measures for the

rehabilitation of the manual scavengers. It is important to make sure that the manual scavengers are provided with sustainable and appropriate jobs so that the marginalised scavengers can get a second chance at re-integrating with society, for instance, an apparel label is run entirely by former manual scavengers in Dewas, Madhya Pradesh. The gases emitted inside the sewage as a byproduct of anaerobic decomposition can be utilized to produce energy for domestic and commercial applications because of combustible nature and calorific properties [20].

CONCLUSION

It is essential to understand the elements and processes which create a social divide and subordinate, exclude and marginalize a certain ostracized segment of the society. It is the culture and philosophy of caste which validates the casual subjection of these workers to hazardous and humiliating manual labor of cleaning sewers and septic tanks. The occupational health hazards and diseases among persons engaged in sanitation and allied work for cure and prevention needs specialized attention and mainstreaming into the public domain. A smart mix of the four approaches suggested is required to bring about the end of the scourge of manual scavenging and for this, incorporation of global best practices and technological solutions should be prioritized, so as to achieve the national sustainable development goals.

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REFERENCES

1. Saikia A, Longkumer NA (2016) In a fulcrum: Revisiting the conditions of manual scavengers in India. *J Soc Res Policy*. 105-110.
2. Tiwari RR (2008) Occupational health hazards in sewage and sanitary workers. *Indian J Occup Environ Med*. 12(3):112.
3. Bajpai GS (2019) Technology, training can stop sewer deaths. *TribuneIndia*. 24:1-12.
4. Aparajita B (2014) The prohibition of employment as manual scavengers and their rehabilitation act: A review. *Space Cult*. 12: 12-14.
5. Susan C (1999) Cities sewers and poverty: India's politics of sanitation. *Env Urban*. 145-158.
6. Susan C (2011) The politics of sanitation in India: Cities, services and the state. In *new perspectives in South Asian history*, by Niels Brimnes Sanjoy Bhattacharya. Hyderabad: Orient Blackswan. 10:14-16.
7. Khan FL, Pathak S (2019) A robot might take his job and that's good news. *NPR org* 2020.
8. Jayati G (2017) Sanitation workers in india. *Frontline*. 15:1-8.

9. Feo GD, Antoniou G, Fardin HF, Gohary FE (2014) The historical development of sewers worldwide. sustainability. 3936-3974.
10. Purushottam A, Abhiram M (2012) A study on morbidity profile of sewage workers in Mumbai city. Int J Collaborat Res Int Med Pub Health. 450-463.
11. Lofrano G, Brown J (2010) Wastewater management through the ages: A history of mankind. Sci Env. 10: 5254-5264.
12. Mander H, Sharma S, Verma V (2019) The frequent deaths of India's sewer workers isn't a governance failure-they are rooted in caste. Scroll. 17:2020.
13. Ou ZM, Yao H, Kimura K (2007). Preparation and optical properties of organic nanoparticles of porphyrin without self-aggregation. J Photochem Photobiol A Chem. 189(1): 7-14.
14. Parikh RY, Singh S, Prasad BL, Patole MS, Sastry M, et al. (2008) Extracellular synthesis of crystalline silver nanoparticles and molecular evidence of silver resistance from *Morganella* sp.: Towards understanding biochemical synthesis mechanism. Chem Bio Chem. 9(9): 1415-1422.
15. Park J, Joo J, Kwon SG, Jang Y, Hyeon T (2007) Synthesis of monodisperse spherical nanocrystals. Angew Chemie Int Ed. 46(25):4630-4360.
16. Patel K, Kapoor S, Dave DP, Mukherjee T (2005) Synthesis of Pt, Pd, Pt/Ag and Pd/Ag nanoparticles by microwave-polyol method. J Chem Sci. 117(4):311-316.
17. Pereira L, Mehboob F, Stams AJ, Mota MM, Rijnaarts HH, et al. (2015) Metallic nanoparticles: Microbial synthesis and unique properties for biotechnological applications, bioavailability and biotransformation. Crit Rev Biotechnol. 35(1):114-128.
18. Perreault F, Popovic R, Dewez D (2014) Different toxicity mechanisms between bare and polymer-coated copper oxide nanoparticles in *Lemna gibba*. Environ Pollut. 185:219-227.
19. Pileni MP (1993) Reverse micelles as microreactors. J Phys Chem. 97(27):6961-6973.
20. Prabhu BM, Ali SF, Murdock RC, Hussain SM, Srivatsan M (2010) Copper nanoparticles exert size and concentration dependent toxicity on somatosensory neurons of rat. Nanotoxicol. 4(2):150-160.