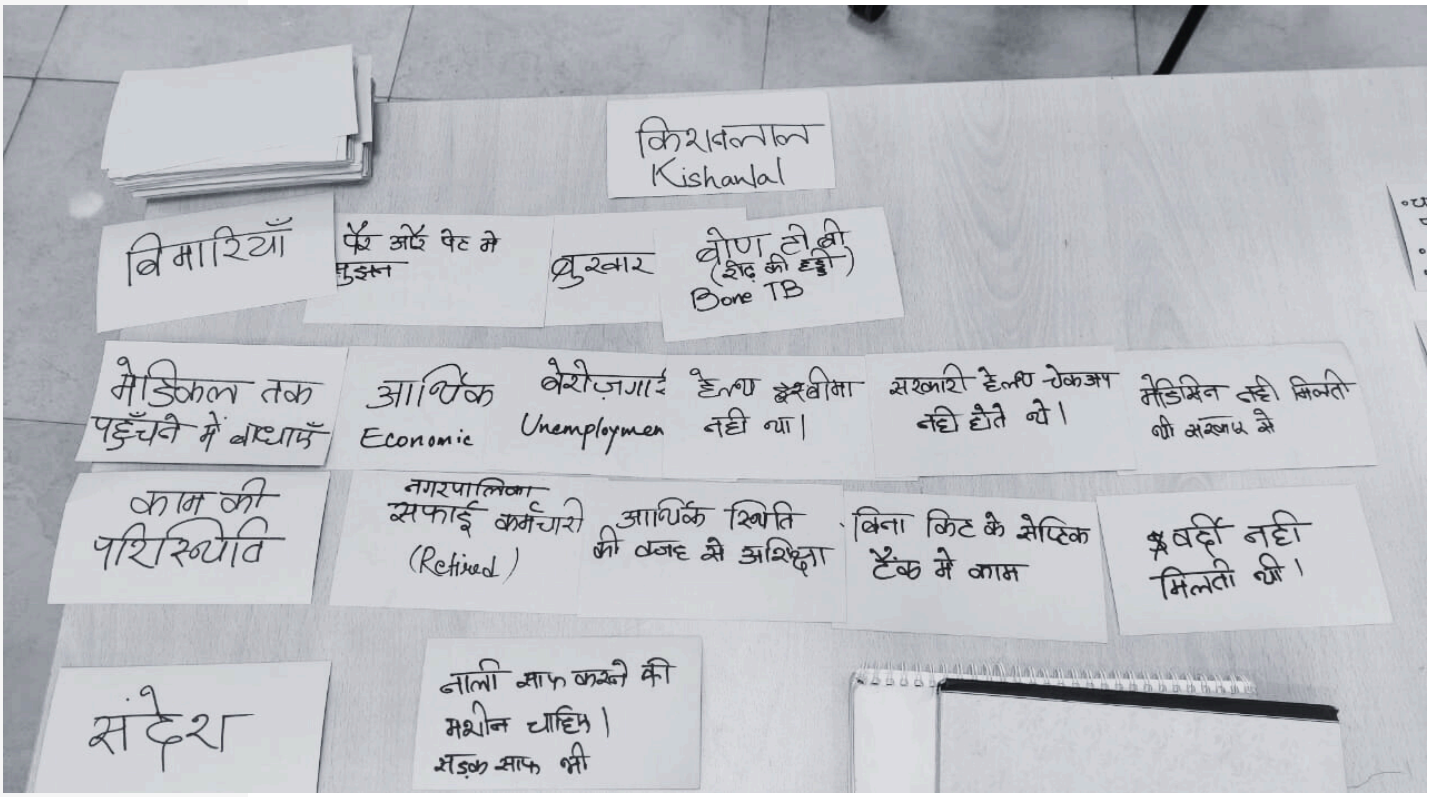
SOUTH ASIAN SANITATION WORKER AND LABOUR NETWORK

THE TRANSFORMATIVE ROLE OF SCIENCE AND TECHNOLOGY IN ELIMINATING MANUAL SCAVENGING



ACKNOWLEDGEMENT

The South Asian Sanitation Worker and Labour Network (SASLN) extends its heartfelt gratitude to all the sanitation workers and their families who generously gave their time, shared their experiences, and contributed to the development of this report.

We would like to express our special thanks to Prof. Prabhu Rajagopal and the team at Solinas for their invaluable support in the preparation of this report. We are also grateful to Dr. Taslimarif Saiyed for his expert guidance, which significantly shaped the direction and depth of this report.

We are especially thankful to the team at Partners in Change and Dr. Sarah Hyder Iqbal for their unwavering cooperation and continued support during every stage of this journey.

This report is the result of a collective effort, and we are truly grateful to everyone who contributed their time, knowledge, and solidarity.

RESEARCH TEAM

Lead Research Team
Anil Kumar Balmiki
Jogendra Singh Parihar
Neha Narayanan
Pradeep Narayanan
Ranbir Kumar Ram
Sarah Hyder Iqbal
Tarini Shipurkar

Data Collection Team
Anju Kumari
Dinesh Hela
Gurpreet Kaur
Ishwar Waghela
Jai Gopal
Kamaljeet Kaur
Ramkui Kachui
Rohit Basfore
Seema Sapriban
Sudha Jhinjot
Themyophi KH
Vikesh Kumar

Data Collation
Neha Narayanan

Data Analysis Team
Anil Kumar Balmiki
Anju Kumari
Dinesh Hela
Gurpreet Kaur
Ishwar Waghela
Jai Gopal
Jogendra Singh Parihar
Kamaljeet Kaur
Neha Narayanan
Pradeep Narayanan
Ramkui Kachui
Ranbir Kumar Ram
Rohit Basfore
Sarah Hyder Iqbal
Seema Sapriban
Sudha Jhinjot
Tarini Shipurkar
Themyophi KH
Vikesh Kumar

Report Writing
Neha Narayanan

Report Designing
Neha Narayanan

TABLE OF CONTENTS

INTRODUCTION

Indian society is marked by deep-rooted complexities, where identities are shaped not only by religion, and class but also by caste that creates social hierarchies. Among the most dehumanizing manifestations of this structure is the practice of manual scavenging, where one person is forced to clean another's waste. The practice of manually removing human excreta from dry toilets with bare hands, brooms, or metal scrapers, and carrying it in baskets to disposal sites, is not only barbaric but represents one of the most severe violations of human rights. This inhumane practice has persisted for centuries, despite long-standing opposition and legal measures aimed at its eradication. Manual scavenging remains a cruel, humiliating task, disproportionately affecting marginalized communities, particularly Dalits. In an effort to count individuals involved in the hazardous task of cleaning sewers and septic tanks across India's cities and towns, government data collected from over 3,000 urban local bodies in 29 States and Union Territories reveals that 91.9% of the 38,000 workers profiled to date belong to Scheduled Caste (SC), Scheduled Tribe (ST), or Other Backward Class (OBC) communities[1].

OF THE 1.2 MILLION MANUAL SCAVENGERS IN INDIA, ABOUT 95% TO 98% OF THEM ARE WOMEN

Manual scavenging is not only a caste-based but also a gender-based occupation (Kumar & Preet, 2020). They are forced to clean dry latrines, carry loads of excrement in leaking cane baskets, clear sewage, discard placenta post-delivery, work on railway tracks, and exhume dead bodies while enduring sexual harassment, social exclusion, dismal wages, and a

lifetime's worth of trauma. Households with dry latrines prefer women to clean the excreta instead of men, as they are located inside the house. Women bear the intersections of both patriarchy and casteism[2].

Manual scavengers often remain trapped in this degrading work because this remains their only source of income and they rely on daily food donations for their survival. To leave manual scavenging, they need immediate access to alternative employment, but they face numerous barriers to entering the broader labor market. These obstacles include social and economic boycotts imposed by oppressor caste communities as retaliation for refusing to clean toilets, as well as discrimination based on gender and caste, which limits their access to other forms of employment. Additionally, corruption further exacerbates their situation, with some being asked to pay bribes for appointments to government positions reserved for marginalized groups, making it even more difficult to break free from this cycle of exploitation.

Despite numerous laws aimed at creating a more equitable society, the conditions of those engaged in scavenging have remained appalling. It is a grim irony that, decades after India's independence, it was only in 1993, and more recently in 2013, that the Government of India enacted specific legislation to ban this degrading and inhumane practice. The Supreme Court of India declared manual scavenging a punishable offense, leading to the enactment of the "Prohibition of Employment as Manual Scavengers and Their Rehabilitation Act" in 2013. Despite this legal framework, manual scavenging continues unabated across the country, in urban, rural, and semi-urban settings alike.

While the Act stipulates that mechanized systems must replace manual labour for cleaning sewers, septic tanks, and other sanitation facilities, manual scavenging continues unabated across the country. The science and technology community in India has been

inadequately engaging with the issue of manual scavenging too, which is evident in the growing innovations and investment in sectors like space, defence, agriculture, retail, and telecommunications, leaving the sanitation sector reliant on outdated methods and cheap manual labour, reinforcing hazardous working conditions.

.

Technological innovation holds immense potential to replace manual labour in hazardous waste management, offering safer, more dignified alternatives for sanitation workers. By examining existing and emerging technologies, as well as the challenges in their implementation, this paper will highlight the critical role that science and technology must play in making manual scavenging a relic of the past

METHODOLOGY

1. An online discussion held on 13 August 2024, organised by SASLN with one of the companies that have developed robotic scavenger machines, Solinas, to understand the challenges in uptake and scaling up of robotic scavengers. The discussion was attended by Prof. Prabhu Rajagopal, co-founder of Solinas.

2. A study on occupational, environmental safety and health (OSH) and mental health of sanitation workers conducted by South Asian Sanitation Workers and Labour Network (SASLN) between June-July 2024 in 10 states across India - Assam, Bihar, Delhi, Gujarat, Manipur, Meghalaya, Punjab, Uttar Pradesh, Uttarakhand, and West Bengal. The study was conducted to understand the availability and accessibility of health services and protective equipment and tools for sanitation workers. We conducted over 510 interviews using a structured questionnaire with sanitation workers, of which 73 are manual scavengers.

3. A study on the status of health of sanitation workers conducted by SASLN in February 2024 in Delhi and Farrukhabad, Uttar Pradesh. We conducted social mapping of the basti/area and conducted in-depth interviews with 10 respondents from each location. Of the 20 respondents.

4. A reflection, interaction and solution analysis workshop organised by SASLN and Partners in Change, held between 14 and 16 December 2022 in Delhi to explore the potential solutions for various challenges faced by sanitation workers including manual scavenging and drawbacks of implementing those solutions.

WHO IS A MANUAL SCAVENGER?

Section 2 (g) of the **Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013** (hereinafter the PEMSR 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...and the expression "manual scavenging" shall be construed accordingly".

The different kinds of manual scavenging acts recognised by the government are:

- **Dry Latrine Cleaning:** A sanitation worker goes to someone else's house, cleans their human waste, carries it on their head, and disposes of it elsewhere.
- **Septic Tank Cleaning:** This involves workers entering septic tanks, often 10-14 feet deep, to manually remove human waste.
- **Sewer and Drain Cleaning:** Workers often clean sewers and drains, sometimes as deep as 25-30 feet, completely submerged in waste.
- **Railway Track Cleaning:** When passengers use toilets on trains, the waste falls directly onto the tracks. Sanitation workers are responsible for cleaning this waste with their hands due to the lack of technical equipment.
- **Drain Cleaning:** In some households, waste flows directly into drains or ditches. Sanitation workers have to clean these drains manually.
- **Pit Cleaning:** In areas without proper toilet facilities, households would dig pits in their courtyards for defecation. Sanitation workers would sprinkle ash

over the waste and manually collect it in baskets for disposal elsewhere.

However, these categories do not completely capture all kinds of manual scavenging. Some practices, such as cleaning open defecation sites or handling waste in hospitals, are still not covered under the law.

- **Open Defecation:** Even today, in rural areas and during floods, people defecate in open spaces like along highways or embankments. Sanitation workers are tasked with cleaning this waste by hand.
- **Hospital Waste:** In hospitals, patients who are bedridden or in intensive care often defecate in containers, which are then emptied manually by sanitation workers.

These practices are not yet considered manual scavenging highlighting that it continues in various forms despite legal prohibitions.

Moreover, inadequate surveys and the failure to accurately identify people still engaged in manual scavenging remain a significant issue. The Supreme Court has criticized government surveys as ineffective, particularly highlighting the lack of progress in the 2013 central government survey, which identified only a small fraction of the actual number of manual scavengers.

Different sources provide widely varying estimates of the number of manual scavengers in India. For example, the 3rd and 4th reports of the National Safai Karamchari Commission estimate 5,77,228 manual scavengers, while the 2002-03 report of the Ministry of Social Justice and Empowerment lists 6,76,009. In contrast, the NGO Safai Karamchari Andolan, which works for manual scavengers' rights, estimates around 1.2 million. Meanwhile, the Socio-Economic Caste Census report of 2011 records 1,80,657 manual scavengers. To address these discrepancies, the government should conduct periodic and comprehensive surveys, at least once every three years, either independently or in collaboration with credible NGOs.

CASE STORY: ANITA DEVI*

Anita Devi, a resident of Babhnaul village in Rohtas district, Bihar, was involved in the hazardous practice of manual scavenging. Like countless others, her day began early in the morning as she made her rounds cleaning dry toilets in several households. For years, Anita Devi's daily routine involved carrying human waste on her head in a metal basket and disposing of it at a distant location, a task that exposed her to not only physical health risks but also deep social stigma.

One day, while on her usual rounds, Anita Devi started to feel dizzy after finishing work in three households. She was carrying a basket of human waste on her head when she suddenly collapsed in the middle of the road. As she fell, the contents of the basket spilled over her entire body.

Despite her evident distress, lying in pain on the ground, no one from the nearby community came forward to help her. It was only after someone from her colony was alerted that she was taken to a small, local hospital.

Upon arrival at the hospital, the doctor initially refused to touch Anita Devi, citing her low caste and the fact that her body was covered in human excreta. Only after a relative cleaned her did the doctor agree to examine her. It was discovered that she had suffered a stroke, leaving half of her body paralyzed.

The incident brought immense hardship to Anita Devi's family. She was the primary earner, responsible for managing household expenses, including groceries, her children's education, and other necessities. Anita Devi's husband worked cleaning septic tanks, but most of his earnings were spent on alcohol and gambling.

*name changed to ptotect identity

Anita Devi had two daughters: Madhuri*, aged 13, who was in 6th grade, and Shreya*, aged 12, who studied in 5th grade at a local government school. The family's financial situation worsened as Anita Devi, now paralyzed, could no longer continue her work. Her daughters, who had often seen her struggle, were devastated. They had always told their mother, "We will study hard, get good jobs, and free you from this work."

Faced with the grim reality of their situation, Madhuri, the elder daughter, made the difficult decision to drop out of school to take over her mother's job. At only 13 years old, she understood that without her mother's income, the family would not be able to survive. Despite her young age, Madhuri took on the same degrading task of manual scavenging that her mother had done for years.

Organizations like SASLN, in collaboration with other nstitutions, came forward to provide financial assistance for Anita Devi's medical is allowed her to receive some treatment. Although the fund care, her condition did not improve to the point where she could resume work. The loss of Anita Devi's ability to earn and Madhuri's need to abandon her education to support the family highlighted the entrenched cycle of poverty and marginalization faced by manual scavengers.

Anita Devi's case is a poignant example of the physical, social, and economic toll that manual scavenging continues to inflict on marginalized communities in India. Despite government policies aimed at eliminating manual scavenging, the practice persists, perpetuating a vicious cycle of poverty, ill health, and social exclusion. The burden of this dangerous and dehumanizing work often falls on women and children, who, like Madhuri, are forced to abandon their education and dreams for a life of labor and stigma.

ROLE OF SCIENCE AND TECHNOLOGY IN ELIMINATING MANUAL SCAVENGING

The eradication of manual scavenging in India requires a multifaceted approach, with science and technology playing a pivotal role. While legislation and social initiatives have made some progress, the persistence of this inhumane practice highlights the need for innovative solutions, particularly in infrastructure and technological advancements. A combination of modern sanitation systems, mechanized cleaning solutions, and effective policy enforcement can create the necessary conditions for the complete abolition of manual scavenging.

Infrastructure Development

One of the key strategies for eliminating manual scavenging is upgrading sanitation infrastructure. Many areas across India still rely on outdated systems, such as dry latrines, that necessitate manual intervention for cleaning human waste.

The development of modern, hygienic alternatives—particularly flush toilets connected to efficient waste management systems—can greatly reduce the demand for manual cleaning. The government's efforts to construct flush toilets under initiatives like the Swachh Bharat Mission represent a significant step forward, but there is a need for further expansion, particularly in rural areas, where dry latrines are more prevalent. Improved waste management systems, including sewage networks and treatment plants, will also play a critical role in ensuring that human waste is handled in a safe and hygienic manner without the need for human intervention.

Technological Innovation

Technological innovations hold enormous potential to address the challenges of manual scavenging. Mechanized tools, such as sewer cleaning machines, can

replace manual labour in hazardous environments like septic tanks, sewers, and drains. In recent years, innovations in robotics and automated systems have made it possible to clean these waste management systems more efficiently and safely. Robots designed to clean sewers, for instance, can perform tasks that previously required human scavengers to enter toxic and dangerous spaces. Moreover, the use of mechanized vehicles for emptying septic tanks can eliminate the need for manual scavengers from the entire process. Prioritizing the development and deployment of these technologies is crucial in ensuring that no human is forced to clean human waste.

Robotic machines have the potential to transform the sanitation sector by making the work more professional and removing the stigma associated with manual scavenging. Technology elevates the status of the profession and provides workers with choices, offering pathways for economic development and educational opportunities. For those who choose to remain in the sanitation profession, the use of machines ensures the dignity of labour, moving them away from hazardous conditions.

EXISTING ROBOTIC SCAVENGERS AND CHALLENGES

Robotic scavenger machines represent a crucial step towards eliminating the need for human labour in hazardous waste management, particularly in tasks like cleaning septic tanks, sewers, and drains. Several innovations have emerged in recent years that have attempted to resolve the issue.

Sewer Drain Jetting Truck: This truck-mounted machine uses high-pressure water jets to remove blockages such as grease, sand, and other debris from pipes. It is effective in all weather conditions.

Sewer Jetting and Flushing Machines: These jet-powered devices are designed to clear obstructions and flush sewers clean. They can pulverize collected waste, wastewater, and sludge in the sewer using cutting blades that penetrate tough blockages.

Gas Detector Masks: These masks are equipped with sensors to detect toxic gas concentrations, such as carbon monoxide, hydrogen sulfide, and methane. They can trigger alarms and work with a venting system to drain out dangerous gases.

BANDICOOT

Developed by Genrobotic, Bandicoot is India's first sewer-cleaning robot, inspired by the design of a spider (see figure 1). Bandicoot has two structures. One is the robotic unit with an arm and four legs that enters the manhole and handles the cleaning operation. The other is a control panel unit that stays outside the manhole with the person controlling or monitoring Bandicoot. Various sensors help Bandicoot measure different environmental parameters like manhole dimensions, material and chemicals inside the manhole, humidity, temperature and so on. The robotic arm has five degrees of freedom with 360-degree

movement capacity. A bucket unit of 18 litres capacity is attached to collect waste.

The cleaning process can be done in two modes: automatic or semi-automatic. Automatic cleaning can be applied to standard manholes. It is powered by artificial intelligence (AI) programs based on data collected by sensors. The robotic unit moves inside the manhole by itself and cleans on its own. For non-standard manholes, the semi-automatic control is brought into play. The human being controlling the robot can use the control panel that has a display screen to position Bandicoot inside the manhole. Cleaning is done automatically.

It comes in different versions, ranging from basic to advanced models with six cameras. Priced between ₹25-₹35 lakh, it has been deployed in states like Kerala, Tamil Nadu, Andhra Pradesh, Gujarat, and Haryana. The company provides one week of training for manual scavengers, ensuring the user interface is simple and easy to operate.

Figure 1: Bandicoot

HomoSEP

Developed by Chennai-based start-up Solinas, HomoSEP is a septic tank cleaning product as shown in figure 2. The start-up has built a complete end-to-end water sanitation management system which includes a mix of hardware devices and a software platform.

It has a multiple blade system that mixes the sludge, a camera, and a suction pump that goes inside. The entire system is controlled by a remote controlled joystick. At the click of a button the suction pump can transfer everything into the tank through a pipe. The machine is designed to fit narrow lanes, comparable to the width of an auto-rickshaw. The robot typically runs on the engine of the prime mover, such as an auto-rickshaw, making it energy-efficient and practical for use in various settings.

With customisations available based on the need, HomoSEP is priced between ₹15-₹40 lakh and is currently being used in states like Bihar, Rajasthan, Uttar Pradesh, and several southern states. Solinas provides training and support, with manuals available in multiple languages. A Solinas representative stays on-site for a month after installation to assist with any issues.

Figure 2: HomoSEP

KAMJET-GR:

Developed by Kam-Avida, as shown in figure 3, the truck chassis-mounted jetting cum grab cum rodding unit is capable of simultaneously or independently de-silting sewer mains up to 20 meters deep through power jetting and siphoning of silt and debris using high vacuum flow. It can also transport the extracted waste to a designated disposal site, where it can be emptied either by gravity or through tank tipping. And the chamber extends up to 20 feet without the need for human entry.

Figure 3: KAMJET-GR

SEWER CROC

Developed by a Bengaluru-based company, Ajantha Technologies, this machine was designed by a retired specialist from Hindustan Aeronautics Ltd to clear blockages effectively.

As shown in figure 4, like a crocodile, it would swim the sewer lines, and clean them of silt and blockages using its robotic arm.

Figure 4: Sewer Croc

Despite significant government investments in advanced technologies, including space exploration and quantum computing, the sanitation sector has not received comparable attention. Septic tank cleaning technology remains underfunded, reflecting systemic inertia and a lack of .

prioritization by policymakers This disconnect between innovation in other sectors and the neglect of sanitation technologies poses a significant challenge for the adoption of robotic machines in waste management.

The adoption of robotic scavenger machines, such as Solinas' HomoSEP, holds great promise in eradicating manual scavenging. However, the process of scaling up this technology faces numerous challenges, both systemic and socio-economic. During discussions with experts, several key barriers were identified that hinder the widespread implementation of these machines.

A critical barrier lies in the government tendering process. Contracts for sanitation services are often awarded to companies that continue to exploit manual labor. These companies profit from paying low wages to sanitation workers, even when machines like HomoSEP are available. This practice undermines the potential of technology to replace dangerous manual scavenging practices. To address this, it was suggested that government contracts must stipulate that payments are contingent on the actual use of approved mechanized equipment, preventing cleaning companies from exploiting manual labor while still being compensated.

One of the significant obstacles is the limited awareness about the existence and benefits of robotic scavenging machines, both among the general public and within the sanitation sector. Without widespread knowledge of the technology, sanitation workers and municipal bodies remain reliant on traditional, hazardous methods of waste removal. Raising awareness about the availability and potential of these machines is crucial for their adoption on a larger scale.

CONCLUSION

While science and technology can offer solutions to the practical aspects of manual scavenging, the enforcement of laws remains equally critical. The enforcement of the PEMSR Act 2013 has been inconsistent. To truly address this issue, stringent monitoring and accountability mechanisms must be in place to ensure compliance. Technology can assist in this aspect as well, with the use of digital tools to track and report violations, and ensure that responsible parties are held accountable. Government initiatives should also focus on ensuring that sanitation workers are provided with adequate training to operate mechanized systems safely and effectively, reducing the reliance on human labour in dangerous tasks.

Beyond infrastructure and policy, the rehabilitation of manual scavengers requires a broader, more inclusive approach. Merely providing economic compensation or alternative employment opportunities is insufficient. A comprehensive support system is necessary, including skill development programs to help former manual scavengers transition into new professions. Additionally, mental health services must be provided to address the psychological trauma associated with years of manual scavenging. Social inclusion efforts must also work to dismantle the caste-based discrimination that continues to stigmatize sanitation workers. Eradicating the social and cultural biases tied to sanitation work is key to ensuring that manual scavengers are not only freed from degrading labour but are also reintegrated into society with dignity and respect.

REFERENCES

Chandure, Priyanka & Waghmare, Charuta & Ansari, Khalid. (2020). Minireview of New Technologies Over Manual Scavenging for Sewer Cleaning. Volume: 2020,. 133 - 139.

Hindu (2024): "92% of workers cleaning urban sewers, septic tanks are from SC, ST, OBC groups," 29 September, https://www.thehindu.com/news/national/92-of-workers-cleaning-urban-sewers-septic-tanks-are-from-sc-st-obc-groups/article68697861.ece

Human Rights Watch (2014): "Cleaning Human Waste: Manual Scavenging, Caste, and Discrimination in India," Human Rights Watch Report, 2014, https://www.hrw.org/report/2014/08/25/cleaning-human-waste/manual-scavenging-caste-and-discrimination-india.

Kumar, S., & Preet, P. (2020). Manual scavenging: Women face double discrimination as caste and gender inequalities converge. Economic and Political Weekly, 55(26–27), 1–14.