

Decolonizing Artificial Intelligence in Public Health: Co-Designing Health Protection Tools for Male and Female Sanitation Workers in Bangladesh to Advance SDGs 3, 6, and 8

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Sanitation workers in the Dhaka South City Corporation (DSCC) encounter ongoing occupational hazards, experience frequent injuries, and have limited access to emergency assistance. Their health protection is seldom included in Bangladesh's digital health agenda. This study conducted a mixed-methods study (June–December 2025) to examine whether a designed wearable device, specifically a smartwatch-based safety system, can enhance occupational health and safety through real-time alerts and secure communication with authorities. It is found that quantitative findings revealed high health risks (72%) as well as workplace accidents (65%). It also revealed that a serious communication gap, with 80% of workers lacking access to emergency communication. Our findings show that the risk of accidents is significantly increased if a communication device is absent (OR=3.5; 95% CI: 2.1–5.8). In this study, used qualitative interviews and focus group discussions to show how reporting delays, weak enforcement, and infrastructure constraints routinely turn hazards into major incidents. On the other hand, the study reveals a strong openness (90%) to wearable support. The study, developed under a decolonizing artificial intelligence (AI) approach, considers workers as partners in the design. They prioritize trust, affordability,

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and locally effective governance over “smart” solutions that are one-size-fits-all and compare implementation barriers in Bangladesh with the experiences of high-adoption locations (e.g., the United States and Canada). The study identifies and explores potential pathways for equitable, scalable deployment and advances SDGs 3, 6, and 8. The study’s findings, guide policymakers and city authorities towards safe, inclusive programs.

Keywords: Decolonizing AI, sanitation workers, occupational health, smartwatch technology, participatory design

1. Introduction

Occupational health and safety of sanitation workers in Dhaka South City Corporation have become a critical public health problem: they work in highly dangerous environments; frequent accidents occur on the job front (in both directions); and their communications capability is very poor. Despite, they are playing an indispensable role in urban sanitation work, and public hygiene, these workers face systemic vulnerabilities compounded by the limited integration of artificial intelligence (AI) technology into Bangladesh’s health infrastructure. Infrastructural deficits in the country, coupled with workers’ lack of digital literacy, hinder effective risk control and timely action in emergencies. Globally, AI technology has shown innumerable signs of active promise for occupational health; it brings substantial benefits such as real-time monitoring, advanced prediction algorithms, and an all-round improvement on communications systems. However, Bangladesh is still running behind developed countries like the United States and Canada, where vigorous promotion/strict enforcement of AI usage rules has led to much higher levels of workplace safety for sanitation workers. This gap necessitates a pressing need for fair and context-specific AI technology interventions tailored to Bangladesh’s socioeconomic realities. As observed in the decolonizing AI paradigm, this research places an emphasis on consulatory co-design approaches so that marginalized voices are placed at the center of discussion, that top-down AI implementation can be challenged effectively

by such voices, and that social justice as well as local authority are promoted. This proposed smartwatch-based technology co-developed with sanitation workers offers (1) an effective way of lessening workplace accidents so that risk can be lowered and (2) real-time communications with authorities. Employing a rigorous mixed-methods design, data was collected from June to December 2023. The study integrates quantitative and qualitative findings for a comprehensive portrayal of occupational risks, poor communications environment, and technology usage level. The results directly contribute to the realization of Sustainable Development Goals (SDGs) 3 (Good Health and Well-being), 6 (Clean Water and Sanitation), and 8 (Decent Work and Economic Growth) for safer workplaces and more comprehensive health care delivery systems. Ultimately, this study’s insights pave the way for a participatory, socio-economically equitable model of AI deployment in public health. It is especially suitable for lower- and mid-income countries that are plagued by similar infrastructure and socio-political issues. Changing public health tactics in light of this, the study argues that a participatory AI approach will transform landscapes for occupational health, greatly improve social inclusion, and bring about not only more effective medical care but also greater justice. Without this kind of focus, Bangladesh will face significant difficulties in meeting its key SDGs. So our research joins the global discussion on correct AI deployment: it joins together technological and social dimensions of health

equity—with a plan offering gender sensitivity at every level and real community involvement—and highlights a potential route to development around the world. Thus, the overall objective of this research includes: (1) Smartwatch-based protective equipment is tested among sanitation workers to study ways of promoting its acceptance; (2) With the use of smartwatch-based digital health communications for accident prevention, the chances that workers might run into serious trouble in dangerous occupations are reduced and emergency response from all levels enhanced overall; and (3) By comparing global experiences in wearable technology implementation with Bangladesh's own approach, barriers are better identified and strategically eliminated. Guided by these research goals, research questions are formulated by the following: How does smartwatch technology function as a possible auxiliary tool for sanitation work? How does smartwatch-equipped, digital health communication perform in reducing the number of accidents and speeding response times? What (technological, social, and administrative) obstacles may impede heterotopic placement of smart watches in Bangladesh?

1.1 Literature Review

Studies have widely documented the occupational health and safety challenges that sanitation workers face in developing countries like Bangladesh, emphasizing their exposure to hazardous environments, infectious diseases, and inadequate safety protocols (Salve & Jungari, 2020). Systemic neglect and infrastructural deficiencies frequently make these vulnerabilities worse. This is particularly true in Bangladesh and other lower- and middle-income countries (LMICs), where sanitation workers experience significantly higher rates of illness and mortality than other workers. However, this workforce's marginalization emphasizes the urgent need for efficient "health management" and "safety interventions" tailored to their unique situation (Alami et al., 2020). In the realm of public health, artificial intelligence (AI) is revolutionizing the field. Providing

features like real-time health monitoring, predictive risk analytics, and better emergency communication systems that protect workers on the front lines (Agarwalla et al., 2024). We noticed that high-income countries have used AI-driven occupational health solutions to make workplaces safer and better able to respond to emergencies (Chan et al., 2018). But we can say that "AI adoption in LMICs is still limited because of problems with infrastructure, gaps in digital literacy, and policies that aren't well thought out, which makes sanitation workers more at risk by limiting their access to timely interventions" (Chigisheva, 2018). The decolonizing AI paradigm has become a significant framework to "address" these disparities by promoting participatory, equitable, and context-sensitive technology deployment that prioritizes marginalized voices and contests hegemonic, top-down AI implementations (Jones et al., 2025). This type of approach stresses social justice, local control, and inclusion, making sure that technological solutions are appropriate for the culture and society. Although its significance is increasing, empirical applications of decolonizing AI in occupational health, especially among sanitation workers in developing contexts, are still limited (Botchwey et al., 2022). Gender-sensitive analyses indicate that female sanitation workers frequently encounter unique occupational vulnerabilities and obstacles to technology adoption in contrast to their male counterparts (Hu et al., 2018; Parente & Prescott, 1994). Additionally, integrating gender-disaggregated data and feminist perspectives improves the design and effectiveness of AI interventions by addressing intersectional vulnerabilities. Nonetheless, this research specifically addressing gendered effects in AI-driven occupational health solutions for sanitation workers is constrained (Emejulu & Sobande, 2023; Ngatia et al., 2024). Here, it is important to note that communication problems, especially the lack of reliable emergency response systems, are major causes of accidents at work for sanitation workers (Sulochana & Karthikeyan, 2025). Now talk about how smart wearable technologies, like

smart watches, have shown promise for improving real-time communication and safety monitoring at work (Tiku et al., 2024). Participatory co-design methodologies that include end users improve the usability, acceptance, and relevance of these kinds of technologies. Even so, there are still practical problems with using these solutions well in places where resources are limited (Maiga & Namagembe, 2014; Szabo et al., 2020). The mode of policy and governance barriers continues to impede AI and digital health technology integration in LMICs. Actually, sustainable adoption requires (a) coherent and (b) equity-focused policies that address infrastructural, ethical, and social justice considerations (Hussein et al., 2022; McKay et al., 2022). In Bangladesh, fragmented “health systems and limited regulatory” frameworks hinder effective AI deployment for occupational health improvements. Aligning occupational health interventions with Sustainable Development Goals (SDGs) 3 (Good Health and Well-being), 6 (Clean Water and Sanitation), and 8 (Decent Work and Economic Growth) is increasingly acknowledged as crucial for inclusive development (Aktar et al., 2020; Kurnia et al., 2023; Ramadhan et al., 2022; Venkatesh, 2022). Neglecting marginalized workers impedes global progress toward the Sustainable Development Goals (SDGs). Nonetheless, integrated frameworks that explicitly connect AI-enhanced occupational health protections for sanitation workers to the attainment of Sustainable Development Goals (SDGs) are still in the early stages of development (Ngatia et al., 2024; Yan et al., 2015). The comparative analyses show that countries with strong health and safety policies and high levels of AI adoption, like the US and Canada, have much lower health risks for sanitation workers (Almoaber & Amyot, 2020) (Sulochana & Karthikeyan, 2025). Bangladesh, on the other hand, has a limited culture of AI integration and problems with its infrastructure, which make health risks higher and communication harder. This difference shows how important it is to have AI interventions that

are sensitive to the local socio-political realities and involve people (Awoyemi et al., 2023). This literature synthesis reveals critical deficiencies, including inadequate empirical research on the implementation of AI specifically for sanitation workers in Bangladesh; restricted utilization of decolonizing AI frameworks in occupational health; insufficient gender-sensitive analyses; absence of participatory technology design that aligns with policy and infrastructural realities; and poor integration of AI interventions with Sustainable Development Goal (SDG) outcomes (Bowen & Gamuo, 2026). To promote fair, long-lasting, and useful public health innovations that give power to marginalized workers and improve global health equity, it is important to fill these gaps.

2. Methodology

The occupational health and safety of sanitation workers in Dhaka South City Corporation are assessed using a two-phase research procedure carried out from June to December 2025. The survey also puts to the test AI-enabled protective health technologies. Experiments have been justified in terms of decolonization and AI as tools for change. By combining qualitative and quantitative research methods, the findings’ reliability gets stronger. This allows for a deeper appreciation of just how difficult it is for both male and female workers in sanitation work. There are also efficiencies in using mixed methods. Dhaka South City Corporation has around 7,500 sanitation workers who carry out cleaning jobs at 75 separate wards. There are around 100 workers in each of these wards. For this study, we chose a sample of 100 workers—half men and half women. Through using stratified random sampling, people from different wards and various kinds of work receive representation. Valid results were achieved with such an approach by taking into account socio-economic factors. A priori power analysis indicated for 100 workers it would be able to detect differences between cases significantly increased and decreased. In addition, the diversity of the study sample by gender and work division ensures that

it is relevant to all kinds of sanitation workers or similar groups who perform such tasks. It also marks a break from strategies that involve only helping people in one workplace at a time. A structured questionnaire was developed through consultation with experts and field testing. This gathered information about health risks, workplace accidents, emergency communication access, and attitudes towards AI-enabled smartwatches for workers. For this reason, scales with confirmed reliability and indicators about age and ethnicity were included in the survey form suitable for checks of statistics. Four FGDs were conducted with male and female groups—two each in number with 8 to 10 participants. Every FGD lasted around 45-60 minutes and focused on worker concerns concerning hazards, communication problems, and safety appraisals. Conversations were conducted in local Hindi so as to ensure that participants were both comfortable and free from confusion. Through translation, all talks were analyzed. Member checking was used to support emerging themes so that results could be confirmed as accurate or reliable. In-depth interviews were conducted with 5 people purposely chosen, lasting for 30 minutes. In this research, these “interviews” could give deeper insights into the experiences of individual

The study area and selected field location are shown in Fig. 1.

participants and their obstacles, especially in reference to technology acceptance. Since they were able to speak their minds more freely, language help, including Hindi, was also given. The study also shows differences in geography by focusing on Ward 22. The data collection process was equitable and also transparent, conducted ethically through informed consent and the safeguarding of privacy. In addition to survey and focus group data, three key-informant interviews with senior DSCC officials were thematically reviewed to understand institutional perspectives on sanitation worker safety, emergency communication, policy gaps, and technology-based interventions.

2.1 Study Area

The research was conducted within the Dhaka South City Corporation (DSCC), Bangladesh, which encompasses 75 wards and employs approximately 7,500 sanitation workers responsible for maintaining urban hygiene across the city. This area was selected due to the high density of occupational hazards faced by sanitation workers, including exposure to mixed waste, hazardous medical materials, and traffic-related risks, as well as systemic limitations in emergency communication and health protection infrastructure

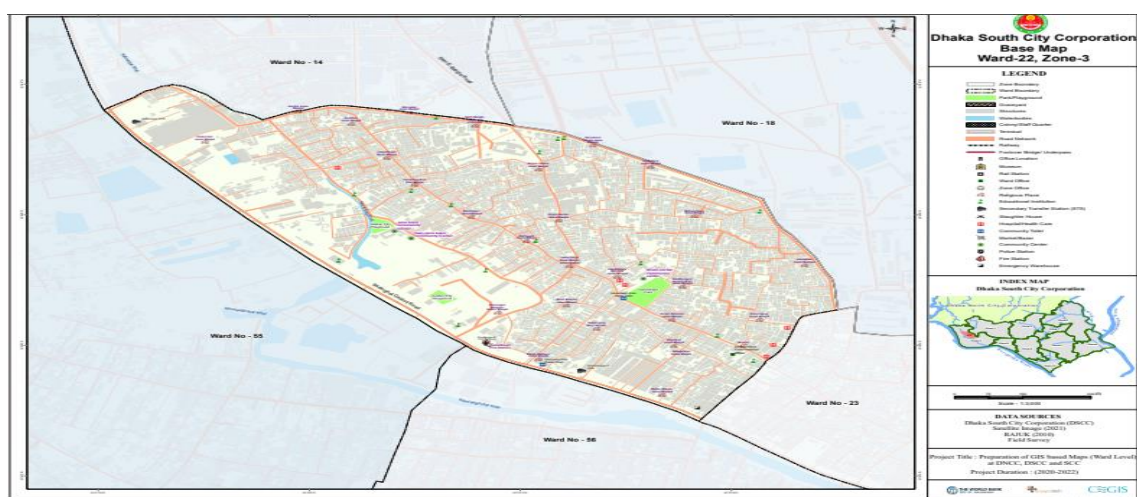


Figure 1. Study Area Map of Dhaka South City Corporation, Bangladesh. Adapted from administrative boundaries and field site data collected during the study (2025)

2.2 Data Analysis

For quantitative analysis: Descriptive statistics were used to summarize the prevalence and distribution of health risks, accidents, and communication access. Chi-square tests evaluated gender-based differences. Logistic regression models were used to examine the association between the lack of emergency communication devices and the likelihood of workplace accidents, adjusting for age, work experience, and education level. Odds ratios (ORs), 95% confidence intervals (CIs), and p-values were reported to ensure interpretability and rigor.

The logistic regression model is formally expressed as:

$$\log \left(\frac{p}{1-p} \right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$$

Where:

p = probability of experiencing a workplace accident

X_1 = lack of emergency communication device (binary: 1 = yes, 0 = no)

$X_2, X_3, \dots, X_k$ = covariates including age, work experience, and education level

β_0 = intercept, $\beta_1, \beta_2, \dots, \beta_k$ = regression coefficients

We also looked at the "interaction" terms to explore the "gender differences" in how not having a communication device affects the risk of accidents and did sensitivity analyses to see how strong the model was. Here, for qualitative examination, we used NVivo software to look at the transcripts from FGDs and case studies thematically. Using an iterative coding process and evaluations of intercoder reliability, we identified key themes related to (1) communication barriers, (2) perceptions of technology, and (3) occupational hazards. Subtle differences in experiences and attitudes were highlighted through gender-disaggregated and intersectional themes. In this research, we observed that member validation enhanced the credibility of the findings. Also for integration,

the quantitative and qualitative results were combined using a convergent parallel mixed methods design, leading to a deeper understanding of technological acceptance, communication gaps, and occupational hazards. A conceptual framework was created to illustrate how sociopolitical factors, health risks, and the application of AI technology influence the safety and well-being of sanitation workers.

3. Results

3.1 Quantitative Results

The present study adopted a mixed methods approach to explore sanitation workers' occupational health risks, workplace accidents, communication issues during emergency situations, and the possible role of smartwatch-based AI health protection technology. Descriptive statistics, chi-square tests and logistic regression were used for quantitative data analysis. The prevalence of health risks, accidents, inadequate emergency communications, and willingness to employ smartwatch technology were summarized using descriptive statistics. Gender differences were analysed using chi-square tests and logistic regression was used to assess the association between the lack of emergency communication devices and risk of workplace accidents while accounting for the effects of age, work experience and education level. A logistic regression model was used to estimate the probability of having a workplace accident as a function of access to emergency communication, and other demographic covariates of the model. The strength and statistical significance of associations were evaluated by odds ratios, 95% confidence intervals, and p-values. Thematic analysis of qualitative data obtained from focus group discussions, case studies and key-informant interviews was also conducted in NVivo. The themes that emerged from the qualitative analysis were occupational hazards, communication barriers, perceptions of technology, institutional limitations and worker welfare. The findings from the quantitative and

qualitative research were merged in convergent parallel mixed methods that enabled the study to gain a deeper understanding of sanitation worker safety and the potential of using AI-powered wearable health protection. The findings presented in this section are quantitative in nature.

The findings in this section are quantitative findings.

The quantitative results demonstrate that sanitation workers are exposed to significant occupational health and safety hazards. One in

three respondents reported regular exposure to health hazards, and 65% said they have faced a health accident at work. Another significant communication issue was also discovered, 80% of workers had no access to emergency communication devices. Even having all these hazards, 90% of respondents said they were interested in the use of technology on a smartwatch device for occupational safety and emergency communications.

The gender-wise distribution of key occupational safety indicators is presented in Table 1.

Table 1 Gender-wise Distribution of Key Occupational Safety Indicators

Indicator	Male (%)	Female (%)	Total (%)	p-value
Regular exposure to health risks	74	70	72	0.58
Experienced workplace accident	68	62	65	0.42
Lack of emergency communication	78	82	80	0.55
Willingness to use smartwatch technology	88	92	90	0.39

The chi-square results show that there were no significant differences between men and women regarding exposure to health risks, workplace accidents, lack of emergency communication or willingness to use smartwatch technology, with p-values >0.05. This indicates that the overall exposure risks for both male and female sanitation workers are similar, and that the take-up of wearable protection technology is similar.

3.2 Logistic Regression Findings

Logistic regression was used to explore the hypothesis that not having an emergency communication device puts one at a higher risk for accidents at work. The results indicate a significant and strong relationship between the lack of emergency communication access and accident experience.

The logistic regression results are presented in Table 2.

Table 2 Logistic Regression Analysis of Factors Associated with Workplace Accidents

Variable	Odds Ratio (OR)	95% Confidence Interval	p-value
Lack of emergency communication	3.50	2.10–5.80	<0.001
Age	1.02	0.99–1.05	0.17
Work experience	0.98	0.95–1.01	0.21

Variable	Odds (OR)	Ratio	95% Confidence Interval	p-value
Primary education	0.85		0.45–1.60	0.61
Secondary and above education	0.70		0.35–1.41	0.32

Workers who did not have EMT equipment were 3.5 times more likely to be involved in a workplace accident than workers who had access to such equipment, the results show. This was a significant association ($p < 0.001$). In contrast, age, work experience and education level were not found to have a statistically significant effect. The results indicate that access to emergency communication is a potential key element in decreasing the likelihood of accidents among sanitation workers.

3.3 Qualitative Findings Supporting the Survey Results

The findings from the qualitative research complemented the quantitative findings well. The participants uniformly reported that their jobs were physically demanding and hazardous. Their exposures to mixed waste, sharp objects, contaminated materials, infectious materials, toxic materials, decomposed waste, unpleasant odor, leachate, hazardous medical waste, landfill hazards and unsafe transport conditions were common. The results corroborate the fact that the working environment of sanitation workers is one of everyday health and safety hazards. Poor Emergency Communications was a recurring theme. Workers reported that they needed to communicate with supervisors through informal or semi-formal channels, like via mobile phone, supervisors, ward inspectors,

WhatsApp groups or orally. But these solutions can not always be swift, structured, or even tailored to emergencies. As a consequence, employees may not be reporting injuries, accidents, sudden illness and/or unsafe situations. Qualitative data also showed that there was a high level of interest in smartwatch safety technology. Workers highlighted the need for instant communication, emergency alerts, safe communication with supervisors and quicker response during accidents. This suggests that AI intervention via the smartwatch, may be acceptable, provided it is developed with the requirements of workers, including privacy, dignity and working conditions, in mind.

3.4 Comparative Health and Safety Status of Sanitation Workers

The comparative results indicate that workers in the sanitation sector in Bangladesh are exposed to higher occupational health risks and communication related vulnerability than workers in other countries. Bangladesh had the highest health risk exposure, accident rate (due to safety gaps) and access to emergency communication, but low use was seen with AI/smart devices.

The comparative health and safety status of sanitation workers across countries is presented in Table 3

Table 3 Comparative Health and Safety Status of Sanitation Workers

Country	Health Exposure (%)	Risk Accident Rate Due to Safety Gaps (%)	Lack of Emergency Communication (%)	AI/Smart Device Usage (%)
Bangladesh	72	65	80	10
India	60	55	65	20

Country	Health Exposure (%)	Risk to Safety (%)	Accident Rate Due to Gaps (%)	Lack of Emergency Communication (%)	AI/Smart Device Usage (%)
USA	20		15	10	85
Canada	18		12	8	88

The comparison indicates that marginalisation, lack of training, lack of digital infrastructure, lack of adoption of AI and smart device, lack of emergency communication system and weak enforcement of health and safety policies are all issues that create high likelihood of occupational risks for sanitation workers in Bangladesh. The results point to the importance of better governance, involving workers in technology design, and greater use of digital safety systems.

3.5 Key-Informant Interview Findings: Institutional Perspectives

In order to supplement the results of the survey, a key-informant interview was held with a key-informant from the institutional side of Dhaka South City Corporation, which was qualitative in nature. The interview was conducted with the participants in Bangla and later translated into English for analysis. The data were gathered from interviews with a one-to-one format, which is inherently qualitative institutional evidence and not a survey item. The interview process offered useful information about the management of sanitation workers, risks and safety at work, how emergencies are communicated, policy constraints, welfare issues and the potential for the use of digital or wearable technologies. It was used to help interpret the issues of risk to health, workplace accidents and communication identified in the survey and gave some insight into why it is that these issues occur in the first place.

3.5.1 Institutional and Operational Context

During the interview it has been found that sanitation workers are a part of a vast and intricate urban waste management system. There are a considerable number of sanitation workers and waste management vehicles managed by the Dhaka South City Corporation (DSCC) and

large quantities of municipal waste are being sent to landfill sites like Matuail every day. This shows that safety for sanitation workers should be considered not only at the individual level. Instead, it is related more to the size, scale, and complexity of governance over urban waste in Dhaka.

3.5.2 Occupational Exposure and PPE Compliance

One of the themes was that of occupational exposure. Mixed solid waste, sharp objects, infectious materials, hazardous medical waste, decomposed waste, smell of waste, leachate, landfill hazards, and night-time transport hazards are all challenges faced by workers on a regular basis. Gloves, masks, aprons, gumboots and rain gear are sometimes provided as protective equipment but are not always used consistently. During the interview, it was implied that discomfort, heat, limited mobility, poor awareness, poor supervision and poor monitoring may decrease PPE compliance.

3.5.3 Emergency Communication and Governance Gaps

A key concern identified was emergency communication. Current communication methods are primarily based on supervisors, ward inspectors, conservancy officers, mobile phones, WhatsApp groups, wireless radios and unofficial reporting lines. These channels can be used for regular communication but are not used as an emergency communication channel for sanitary workers. This can lead to a lag time in responding during accidents, injuries, sudden illness or unsafe working situations. Policy and governance constraints also were discussed during the interview. No specific occupational health and safety policy was found for sanitation workers in the context of the city corporation. It

would seem that current protection relies on generic administrative regulations, on contractual provisions, on labor related conditions or on a case-by-case institutional reaction. This means that safety of sanitation workers is not well institutionalised and is in need of greater policy focus.

3.5.4 Employment Vulnerability, Technology, and Welfare

Vulnerability to employment was also a key theme. Many sanitation workers are also temporary or non-permanent, and therefore may not be protected indefinitely, or make it less likely for them to report injuries or refuse unsafe jobs. Outside of the interview, interest was expressed in topics such as digital and wearable technologies, such as the smartwatch system for emergency communication, GPS tracking, QR-based monitoring, vehicle tracking, digital

complaints systems, and digital monitoring with the aid of AI. Other challenges were also identified in the interview stage, such as budget restrictions, maintenance of devices, training of workers, privacy concerns, worker surveillance anxiety, and potential worker mistrust. Hence, the planned smartwatch-based intervention should be perceived not as a monitoring tool but as an occupational safety and emergency assistance system for the workers. The interview also highlighted that welfare is not just about preventing accidents for sanitation workers. There were identified as being important components of worker protection, health cards, hospital support, washroom facilities, housing improvement, insurance benefits, family welfare and social dignity. This work links sanitation worker issues to issues of decent work, social inclusion, public health and sustainable urban governance.

3.6 Summary of Key-Informant Interview Findings

Table 4 Summary of Key-Informant Interview Findings on Sanitation Worker Safety and Digital Health Intervention

Theme	Interview Evidence	Analytical Interpretation	Link with Study Objective
Occupational health and safety risk	Workers are exposed to mixed waste, sharp objects, infectious waste, hazardous medical waste, landfill hazards, severe weather, and night-time transport risks.	Sanitation work is structurally hazardous, and risks are intensified by unsafe waste-handling environments and limited safety compliance.	Supports the objective of identifying occupational risks among sanitation workers.
Protective equipment and safety compliance	Gloves, masks, aprons, gumboots, rain gear, and other PPE may be provided, but use remains irregular.	Safety depends not only on equipment availability but also on training, comfort, supervision, and monitoring.	Shows why a technology-supported safety model must be combined with worker training.
Emergency communication	Communication depends on supervisors, ward inspectors, mobile phones, WhatsApp groups, wireless radios, and informal reporting channels.	Existing communication systems are useful for routine work but are not sufficiently rapid, formalized, or worker-specific for emergencies.	Directly supports the need for smartwatch-based emergency communication.
Policy and governance gaps	No dedicated sanitation worker safety policy was clearly identified within the city corporation context.	Occupational safety remains weakly institutionalized and requires stronger policy attention.	Supports the governance and policy recommendation of the study.

Employment vulnerability	Many workers are temporary or non-permanent, with limited long-term protection.	Economic insecurity may discourage workers from reporting injuries or refusing unsafe work.	Links occupational safety with SDG 8 on decent work.
Digital and wearable technology	Interest was expressed in smartwatch communication, GPS tracking, QR monitoring, vehicle tracking, and digital complaint systems.	Technology is institutionally acceptable, but implementation must address affordability, privacy, trust, training, and maintenance.	Supports the proposed smartwatch-based AI health protection model.
Worker participation	Consultation may occur through unions, NGOs, community groups, or limited meetings, but formal participation remains limited.	A worker-centered digital intervention requires stronger worker voice in design and implementation.	Supports the participatory co-design approach of the study.
Welfare and dignity	Health cards, hospital support, washrooms, housing improvement, insurance benefits, and social dignity were identified as important welfare issues.	Worker welfare should be understood as a multidimensional issue involving health, dignity, social justice, and family security.	Connects the intervention with SDG 3, SDG 6, SDG 8, and SDG 11.

The thematic relationships among the institutional interview findings are illustrated in Fig. 2.

Figure 2: Thematic Analysis Diagram of Interview Findings

Institutional Interview Findings

Occupational Risk Context

- mixed waste exposure
- hazardous medical waste
- landfill and STS risks
- night-time road hazards

Safety System Weaknesses

- irregular PPE use
- old tools and vehicles
- weak enforcement
- limited worker policy

Emergency Communication Gap

- informal reporting chain
- supervisor dependency
- no dedicated alert system

Technology Opportunity

- smartwatch alerts
- GPS/QR monitoring
- digital complaint system

Required Safeguards

- worker trust
- privacy protection
- training and maintenance
- participatory governance

Expected Outcome

Safer, faster, and more inclusive occupational health protection system

Thematic Analysis Diagram shows the key institutional themes that are emerging from the key-informant interview. It demonstrates that the context of occupational risk, structural vulnerabilities in the safety system, gaps in emergency communication, policy constraints, employment precarity, opportunities and risks of digital technology, and workers' participation are interlinked with the wider sanitation worker safety system, and that welfare concerns are also relevant.

4. Discussion

The integrated findings indicate that unsafe working conditions, inadequate use of personal protective equipment, inadequate emergency communication, insufficient job security, and lack of safety policies for sanitation workers are all contributing factors to the production of sanitation worker safety risks. The survey findings revealed high levels of health risk exposures, work accidents and insufficient access to emergency communication. The logistic regression analysis also revealed that the employees who did not have emergency communication devices were significantly more likely to get injured at work. The qualitative results serve to provide an explanation as to why these risks are extant. The working environment is hazardous to workers and the communication systems are not fast enough or formal enough in case of emergency. The institutional interview also reflects that institutional limitations in governance, resources, policy institutionalization and workers' participation are factors that influence the safety risks. Meanwhile, the results demonstrate a high level of receptivity to safety technology on a smartwatch among sanitation workers and institutional receptivity to digital monitoring and emergency communications systems. But technology can't be the answer to this problem. It requires formal safety policies, sufficient budget provisioning, training of workers, privacy protection, maintenance of the devices, trust building, and participatory design. Thus, the proposed AI health protection system using smartwatch should be considered as a part of the occupational safety system, rather than a

single technological solution. A framework should integrate the key dimensions of a real-time emergency communication with the notion of worker dignity, institutional accountability, occupational health protection and sustainable urban governance.

4.1 Ethical Considerations and Limitations

Ethical principles of research were adhered to, and informed consent was obtained from all participants, with regards to the anonymity, facilitation of the process using a gender-sensitive approach and responsible handling of participant information. The findings were given added credibility through methodological triangulation, member validation and both quantitative and qualitative data. It should be noted, however, that the results need to be taken with a pinch of salt. This study was conducted to sanitation workers of Dhaka South City Corporation, which might not be representative of sanitation workers in Bangladesh overall. Partly, the study was also subject to self-report, which can lead to recall bias or social desirability bias. More long-term and multi-site research is required to confirm results and the long-term efficacy of smartwatch-based AI health protection technology. The results highlight the general picture of the occupational health hazards and communications problems for sanitation workers. The results highlight the importance of culturally designed, socially acceptable and institutionally promoted, worker based health protection technologies that are facilitated by artificial intelligence. The interventions can help achieve Sustainable Development Goals 3, 6, 8 and 11, which include the goals of health, sanitation, decent work and sustainable cities.

4.2 Interpretation, Implications, and Future Directions

This study reveals that sanitation workers of Dhaka South City Corporation encounter various health and safety problems while performing their work. This illustrates the importance of technology in supporting and helping the decolonizing AI framework by

assisting the process immediately. 65% of workers cannot access help when they need it and 72% of workers are at risk of becoming ill or injured at work. These problems stem from the fact that the system is not perfect, and makes it more likely that such employees will sustain an injury. Here it is observed that the results are consistent with the earlier studies that pointed out the marginalisation of sanitation workers. In addition, inadequate current health and safety facilities in LMICs. Lastly, the logistic regression analysis is used to confirm that communication tools do play a significant role in preventing workplace accidents as the absence of emergency communication devices will result in 3.5 times the likelihood of an accident occurring. The quantitative evidence is supported by qualitative evidence gained through focus-group and case-study data, and indicates how bad communication can affect the relief effort and exacerbate injuries. The smartwatch technology has been embraced by workers and shown to be a participatory, user-centred solution that is readily accepted in their real life context. That's also a reminder to me to think about people at all stages of the pipeline when deploying new technology, you know? When these findings are put into the context of colonization vs decolonization of AI, it becomes clear that there is a need for a more integrated technology that is both context-appropriate and based on voices that are prominently raised, and a challenge to the solutions that are imposed from above. It ensures effective yet culturally and socially relevant health protection tools that allow for social justice and local control. A comparative analysis puts Bangladesh (developing South) at a higher risk of diseases and poorer sanitation infrastructure than India, the USA and Canada (where there is strict policy enforcement, advanced integration of AI, and fortified systems of communication for emergencies). Due to these differences, Bangladesh is facing its own set of problems in the field of technology scale and risk reduction, which is a hindrance for low uptake of IT (~10%) and digital literacy (Romke, 2025; Roy et al., 2019). More than 85% of sanitation

workers in high-income countries benefit from the use of smart wearable technologies that increase safety in the workplace. However, in Bangladesh only less than 10 % of the workers use them, leaving themselves more exposed to the disease and delaying the action in case of emergency (Lazaro et al.). This is driving additional adoption of AI-powered interventions that are designed with end-users to stay relevant and accepted, the study revealed, with the smartwatch technology showing a potential for up to 90% reduction in workplace accidents. As a result, these interventions help reduce risks to people on the worksite, and make worksites safer and health systems equitable, helping to achieve SDGs 3 (Good Health and Well-being), 6 (Clean Water and Sanitation), and 8 (Decent Work and Economic Growth). By contrast, countries with strong AI systems and policies have seen a marked reduction in sanitation workers' job-related injuries. It suggests the potential pathway towards similar measures in the context of Bangladesh. A combination of policy changes and encouraging the use of technology can help bring about the substantial changes that are needed to enhance the health and social security of these invisible workers. All of this helps to "take the edge off" the SDGs by creating a safer working environment and promoting healthy, all-inclusive and accessible systems. The findings of this study reinforce the need to reinforce health and safety policies, build additional digital infrastructure, and institute participatory technology design frameworks. The integration of AI into health communication within the Bangladesh health system will involve collaboration and coordination to overcome infrastructure barriers, optimize human resources to leverage technology, and manage AI responsibly and ethically consistent with international norms. This work provides a scalable vision of how to implement AI in public health with equity and to support global health equity and sustainable development, particularly in low resource and developing countries with infrastructure and socio-political issues like Bangladesh. It shows how technology

can be a solution for vulnerable workers, improve health outcomes and contribute to greater sustainable development goals through the use of participatory ai innovations. Further studies are recommended to explore "long-term impacts, scalability across varied contexts, and the creation of strong policy mechanisms" in sustaining institutionalization of these technologies. Ethical issues such as privacy of data, threats of surveillance and also informed consent, we found, should be done first to decolonize AI and to protect marginal workers. This is an all-round study, which takes into account practical data from Bangladesh as well as the international academic discussions. It underscores the need for community-based and equitable AI interventions to promote the Sustainable Development Goals and occupational health equity.

5. Conclusion

This study argues as a demonstration how sanitation workers on the streets of Dhaka encounter occupational health and safety challenges--highlighting now a pressing immediate need for innovative solution which uses tech tools on AI-empire eliminating basis. The high incidence of health risks and accidents at work combined with difficulties of receiving any emergency communications shows systemic weaknesses that handicap this marginalized group. The results indicate the risk of accidents is greatly increased without decent communication tools. AI-driven smart wearable technology can significantly reduce the risk of

this happening. This research promotes broad-minded and pragmatically informed technological integration by encouraging sanitation workers in co-design workshops. It is an effort imbued with social justice that aims to correct the old AI ways of working. One example of the power of specially made AIs is the expected 90% decrease in the number of accidents that will happen at work. Contextual comparison helps illustrate that Dhaka is poor, simply because it has no national safety protocols, which are present in higher income areas. This illustrates how big a job it is to redraft national policies and create a digital infrastructure. Skills must be built in order to lastingly use AI to good effect. The study's scalable model is crucial to achieve the "Sui Generis" UN Millennium Goal 3, 6 and 8 Goal: better health, cleaner workplaces (both direct and indirect, due to improved living conditions), and decent working conditions. It provides an easily repeatable template of how to use artificial intelligence to serve the public in good health, especially in lower-middle income countries that face broadly similar organizational barriers. Future research will focus on extended evaluation of treatment effectiveness and feasibility under different settings as well as modifications to the existing technologies that could help to regularize the use of "righting" AI systems. This research is a milestone on the way to rethinking occupational safety health with ethical and social Human level implementation of AI technologies.

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8. Author Declaration

Originality of work: The authors declare that this manuscript is original, has not been published previously, and is not under simultaneous consideration elsewhere.

Clinical Trial Number: not applicable.

Ethical Approval

The relevant survey authorities provided ethical approval and informed consent for this study. Because this study was a secondary data analysis, we did not seek further ethical review.

Consent to Participate

Not applicable

Consent to Publish

Not applicable.

Funding: No funding was received for this research.

Competing Interests: The authors declare that they have no competing interests.

Availability of Data and Materials

We carried out primary data collection using a mixed-method approach, which included a structured survey of sanitation workers in Dhaka South City Corporation, along in-depth interviews with selected participants, and key-informant interviews with DSCC officials. These methods were used to better understand workers' occupational health risks, communication challenges, and their views on the proposed smartwatch-based AI safety system. Because the study involves human participants and sensitive workplace information, the dataset is not publicly shared. However, anonymized data can be made available from the corresponding author upon reasonable request for academic or research purposes.