Rethinking Urban Safety: Exploring The Design of Safety Robots from Women's Perspectives

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Research has shown that women are more likely to feel unsafe in urban public spaces. This design-led study explores the potential of robots as future safety agents in cities from a human-robot interaction (HRI) perspective, aiming to enhance women's sense of safety and promote gender equality. To do so, we first analysed women's fear of safety in the city through an online diary study, followed by two participatory design workshops that used scenario-mapping to explore women's expectations of safety robots' presence, perception, and role. The results indicate that most women participants hold a positive attitude towards using safety robots in cities and have preconceived notions about their future roles.

This study aims to guide the design and implementation of urban safety robots, ensuring they better adapt to urban environments, meet citizen expectations, and emphasise the potential in promoting gender equality and fostering a more inclusive society.

CCS Concepts: • **Security and privacy** → *Usability in security and privacy*; • **Human-centered computing** → **Empirical studies in interaction design**; • **Social and professional topics** → **Women**.

Additional Key Words and Phrases: Gender Equality, Women's Safety, Safety Robots, Human-Robot Interaction (HRI), Imaginative Design, Women's Perspectives

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1 INTRODUCTION

The process of urbanisation has granted women greater independence, for example, by providing them with more equitable access to employment and services. At the same time, women still face persistent inequalities in terms of work, assets, mobility, governance representation, and safety [7, 44]. Concerns about safety in urban spaces are a prevalent phenomenon in Australian [28]. For example, only about 67% of people feel safe walking alone at night, which is below the OECD average of 74% [28].This leads especially women to avoid areas where they perceive safety risks, thereby constraining experiences and limiting freedom of movement [24, 45]. These gender-based differences in

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fear of safety in public spaces have been shown in numerous studies in criminology [17, 22, 42]. Although women are statistically at a lower risk of victimisation than men [15, 30], they are generally more fearful than men [22, 41]. This heightened fear is partly due to women's greater physical and social vulnerability [22, 33, 39]. In contrast, men tend to discount fear and risk, while women engage in more constrained behaviours and risk-management strategies to prevent victimisation [33, 39].

Around the globe, robots are increasingly being deployed in urban areas to enhance community safety, indicating advancements in policing technical capabilities and effectiveness. This trend has sparked research interest across various disciplines [27, 43, 46]. Notably, some experimental studies have already indicated that women participants have more positive attitudes toward applying safety robots because they perceive robots to be less threatening than human safety personnel [27]. This highlights the potential of robotic technology to address gender-specific safety fears and enhance urban safety in future cities.

However, the deployment of safety robots in urban areas has also sparked controversy. For example, in 2021, the New York Police Department suspended its trial of Boston Dynamics' robotic dog after strong public distrust and backlash regarding its appearance and intended use, with critics describing it as *'creepy'*. Additionally, concerns over data security and police misuse of power have grown, with many feeling *'surveilled'* by these robots [5]. This ***inspires*** that safety robots, when introduced through top-down government decision-making, can undermine rather than enhance the sense of safety among urban dwellers by neglecting their psychological needs and preferences. [9]. Studies have shown that people's perception of robot technology, such as ease of use, usage expectations, and appearance, directly affect its perceived usefulness, usage attitude, and willingness to use [10, 19, 26, 38]. However, the current designs of many safety robots predominately focus on practicality, emphasising the utility of performing specific functions such as assisting law enforcement, real-time monitoring, and public patrols [1, 6]. Therefore, effective integration requires input from the public, including their attitude, perception and expectations.

Using a more imaginative and participatory design approach, we first collected the characteristics of women's geography of fear [48] in the city. We then explored their acceptance of the application of safety robots and their expectations of the roles of safety robots. Our research was guided by the following two research questions:

- RQ1: In which city scenarios do women feel unsafe and desire the presence and intervention of urban safety robots?
- RQ2: What roles and functionalities do women expect urban safety robots to play in these scenarios?

To address the research questions, we initiated a diary study [21] to collect images of unsafe urban scenarios and analyse fear factors among women participants. The study revealed that multiple factors across different urban settings are at play that evoke fear. Using a focus group format, we then guided participants through imaginative exercises. The results indicated a variety of preferences in terms of appearance and roles. Participants' expectations for safety robots were categorised into four general roles: Safety Companion, Safety Monitor, Safety Information Communicator, and Deterrent Robotic Police Officer. We conclude with a discussion on the perception and expectations of women participants towards urban safety robots, addressing both potential and concerns.

2 RELATED WORK

2.1 Women's Safety Fears in Public Spaces

The OECD Better Life Index revealed that just 61 percent of Australian women felt safe walking alone at night in their local area, in contrast to 77 percent of men [28]. A complex range of factors contribute to women's perceptions of

fear about certain public spaces. Internal reasons include social class, age, physical condition, and identity [29], while external reasons may involve factors such as poor lighting in the environment, lack of safety supervision, the male gaze, and specific scenes based on culture [17, 23]. Given these factors, Women's Health East [51] has mentioned using thoughtful design approach to explore the possibility of better enhancing the sense of safety of women residents. In addition, other studies [13, 14, 34] highlight the need to integrate gender perspectives into urban planning, particularly through new technologies, participatory methods, and digital tools to enhance safety and women's freedom. This provides the theoretical support and motivation for this study.

2.2 Urban Safety Robots: Acceptance and Challenges

As robots are increasingly deployed in urban areas, they are reshaping both the city and the daily experiences of communities. [25], using robots as safety agents to enhance the physical safety of communities has attracted attention [27]. A study conducted by Enz et al. [12] found that people are generally more accepting of robots performing safety-related tasks, especially when these involve duties traditionally perceived as dangerous. Research on gender effects in human-robot interaction reveals complex dynamics, with studies indicating that women tend to have higher trust and perceived credibility in safety robots than men [16].

In a recent study by Marcu et al. [27] found that women tend to view safety robots more favourably, perceiving them as less threatening to their safety than human security personnel. This suggests that women may be more inclined to accept robots over human officers.

Although robots are increasingly being deployed for safety and assistance [27], the main challenge is not their production but convincing the public that these robots are safe and trustworthy, especially in collaborative scenarios where humans need to accept information provided by the robots and follow their suggestions [36]. This also has been a primary focus for robot designers and researchers in recent years [36].

2.3 Research Methods and Frameworks in Robot Studies

In recent years, feminist human-robot interaction theory has integrated feminist perspectives into human-robot interaction research, emphasising the need to balance stakeholder relationships through a broader lens while addressing issues of gender and social justice [11, 50]. For example, the "SHE Robots" exhibition highlights diverse robot roles from a feminist perspective, challenging traditional design concepts and redefining robot functions to showcase women's innovative research and creative practices [32]. These theoretical frameworks offer researchers new perspectives, driving a deeper exploration of the views and expectations of women in robotic studies.

To explore the dynamic relationship between the public and robots, relevant research often employs participatory design, imaginative design, and qualitative data methods. For instance, Tian et al. [47] used participatory design in a co-design workshop with "Pepper" to explore user expectations for public robots, demonstrating that co-design workshops effectively enhance user understanding of robotic technology. However, predefined robot images and immature programming platforms limited the results' comprehensiveness. Additionally, based on Sneath et al. [40]'s concept of "imagination technologies," Bina et al. [2], Sumartojo et al. [43] encouraged participants to use scenario collages for imaginative descriptions, employing these collages for both analysis and synthesis [52].

At present, research in the field of safety robots is limited to testing existing robot technologies to collect qualitative data. Although the experimental results provide a preliminary discussion of gender differences, they still lack research on how women's perceptions of safety robots will influence the factors contributing to their safety-related fears and overall sense of safety. For instance, the analysis of interview results conducted by Marcu et al. [27] identified gender-based

differences in the acceptance of safety robots. However, it did not explore the underlying reasons contributing to these differences.

This paper explores the roles of safety robots from women's perspectives, using imaginative and participatory design approaches to understand their safety fears in the urban space and expectations of safety robots. It investigates the future possibilities and societal impacts of safety robotic technology and discusses key design considerations and emerging trends.

3 METHODOLOGY

Our study design is guided by Research Through Design methodology [54] and incorporates Design Fiction approach [3] to explore emerging trends in the design and application of future safety robots. By minimising real technological interventions, the activities encourage participants to engage in imaginative thinking with low-fidelity materials, inspiring more absurd and divergent ideas while reducing solution-oriented results [4]. The study was conducted in two phases. First, we conducted a diary study to allow women to reflect on their everyday lives, identifying potential urban scenarios where they might feel unsafe and their initial willingness to use robots in such situations. These preliminary findings then served as the foundation for the subsequent focus groups, where we further investigated the anticipated qualities and roles of safety robots to enhance their sense of safety in urban spaces.

3.1 Diary Study

To embed women's reflections into their everyday lives via a diary study format [49], we used instruction cards (as shown in Figure 1) that provided an overview of the research, detailed instructions, and a QR code linked to an online survey platform for diary uploads. Prospective participants were instructed to take pictures of urban scenarios that they encountered in daily life and perceive as unsafe. They were further instructed to write a short description of the situation, their emotions, triggers for feeling unsafe in these scenarios, outline their coping strategies, and speculate about the potential of robots as safety agents. Subsequently, they were instructed to upload this information via the online platform.

The instruction cards were handed out by the research team on-site on campus and distributed online among university students. A total of 13 physical instruction cards and 4 digital instruction cards were distributed. The Online Diary Study spanned seven days, during which 19 responses were collected. After removing duplicate and invalid responses, there were a total of 16 valid responses.

3.2 Women's Fear-Inducing Scenarios in Urban Environments

To better identify the drivers of fear experienced by women and to compile a list of fear-inducing urban scenarios, we conducted a manual classification of the photographs base on the location characteristics and type. Participant's descriptive responses were analysed using affinity diagramming [31] and thematic analysis [8]. We began with the initial coding of individual responses to identify core ideas. Similar codes (e.g., "dark," "unknown situation") were grouped to establish broader themes. Ambiguous responses were reviewed and reclassified manually to ensure clarity. This resulted in four categories of locations: open urban spaces, public transportation systems, residential neighbourhoods, and commercial districts. It is worth mentioning that the frequent reference to commercial districts may correlate with a recent knife attack that took place in a central business district shopping mall in the same city where the participants were recruited. While these categories are broad, the data revealed several common characteristics across these locations leading to a sense of unsafe. These include dim lighting, unknown conditions, lack of security guards,

Fig. 1. Online diary instructions card

aggressive strangers, and personal factors such as walking alone. Findings further suggested that fear may arise from a combination of one or multiple factors in certain type of urban settings (as shown in Figure 2).

The examination of the actions our participants suggested to take in fearful situations partially align with García-Carpintero et al. [17], who identified three strategies: avoidance, risk management, and self-empowerment. Interestingly, none of the responses we collected were linked to self-empowerment strategies.

We further summarised women's expectations of safety robots, which fall into two broader categories: enhancing the sense of safety in the space and providing support and companionship. Women expect safety robots to offer monitoring, surveillance, patrolling, and lighting functions, and to respond quickly and seek external assistance in emergencies. Additionally, they hope for companionship and interaction in non-emergency situations, reflecting high expectations for safety robots in both routine surveillance and emergency responses.

3.3 Focus Groups

We conducted two focus group sessions, one in-person and one online. Both sessions were audio recorded, with the online session utilising the collaborative digital whiteboard Miro[1].

While the main activities were consistent across the three activities, the final online focus group involved some additional questions to dive deeper into some of the earlier findings of the in-person session.

[1]https://miro.com/

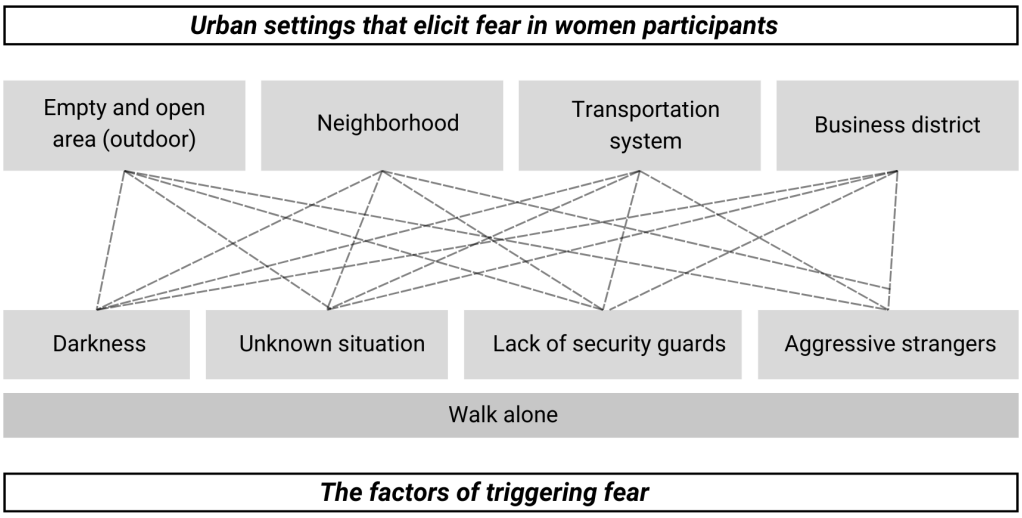

Fig. 2. Factors contributing to the formation of a fear-inducing scenario.

3.3.1 Participants. Participants for this study were recruited through a Women's Network of The University of Sydney and social media. The focus groups included a total of 9 participants, aged 18-34, all of whom identified as women and were from Asia and Oceania. The first in-person focus group had 6 participants, and the second online session had 3 participants. Before the sessions, participants provided written consent and completed a demographic survey (gender, age, occupation). Each discussion lasted approximately one hour. Participants were reimbursed with a $30 gift voucher each. This study was approved by our university's ethics committee.

Activity 1: Imagining Robot Qualities and Integration. Our first activity aimed to elicit the qualities women associate with safety robots; how they imagine and understand safety robots for public spaces; and what they perceive as suitable in different contexts and environments. We followed an imaginative methodology similar to Sumartojo et al. [43] who propose that imagination can help to understand how people feel about robots in public spaces. In their study, they presented participants with collages depicting photographs of public spaces overlaid by various robots.

For our study, we adapted the approach as follows: to cater for our focus on safety in urban environments, we curated four images from the diary study (with each image representing one of the urban settings identified earlier). Each image was accompanied by a short textual description of a scenario that incorporated some of the fear-inducing factors.

Participants were then asked to select from a range of robot images, choosing those they felt best suited the scene, integrated well with the environment and enhanced their sense of safety in this situation. Participants were encouraged to place the robot image onto the scene images to create a complete collage.

We selected four representative robots (shown in Figure 3) from the IEEE Spectrum Robots database [2]. We selected robots to encompass a diverse range of appearance features, including humanoid and non-humanoid forms, various

[2]https://robotsguide.com/

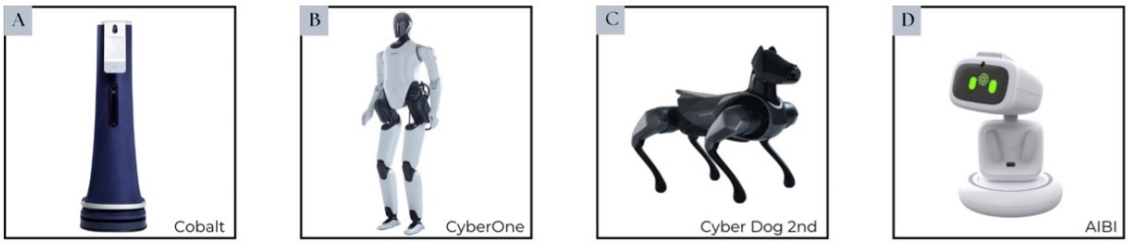

Fig. 3. Four selected robots used in the focus group activity.

sizes, and design styles. In our selection process, we also ensured to represent robots typically associated with different domain contexts. Thus, we included Cobalt and CyberDog previously deployed in security contexts, opposed by the more generic humanoid robot CyberOne that is designed for industrial applications. As companionship was mentioned as another potential feature of safety robots in our diary study, we also included AIBI as an example of a social robot companion, deliberately challenging more conventional perceptions of how a safety robot would look like.

Activity 2: Storyboarding. In this activity, participants were instructed to imagine potential use cases for a safety robot in a given scenario. They were provided with a sequence of images depicting various scenarios (without the presence of a robot), and were asked to create a storyboard describing the use case for a safety robot in each scenario (see Figure 3).

After creating the storyboards, participants were asked to present and discuss them with the group. The purpose of this activity was to gain insights into women's fundamental needs and expectations for safety robots by having them imagine interactions and behaviours.

Activity 3: Brainstorming Issues and Concerns. The last activity aimed to address concerns women have regarding safety robots. Participants were encouraged to use photos from the previous sections as prompts for brainstorming, imagining potential risks and worries associated with integrating safety robots into urban spaces. To do so, participants were asked to record their concerns on sticky notes and place them on a blank whiteboard. Building on the identified concerns identified during the in-person focus group, for the online focus group, we added those concerns to the Miroboard as a starting point, allowing for deeper exploration of these initial thoughts. This approach aimed to gather additional perspectives in identifying and understanding potential issues and concerns in the application of safety robots.

3.3.2 Data Collection and Analysis. We utilised a professional AI-assisted transcription service to transcribe the audio from the focus group sessions and then thematically analysed the transcripts [8]. We synthesised findings on the impact of the robot's appearance on women's perceptions, their expectations of the interactive behaviours of safety robots, and the anticipated roles of future safety robots identified through collaborative activities and discussions. Additionally, we conducted deductive coding of participants' responses to three open-ended questions by reviewing notes on post-it notes, highlighting women's overall attitudes, expected challenges, and potential opportunities associated with the deployment of safety robot technology.

4 FINDINGS

4.1 Robot Preferences and Desired Qualities

4.1.1 Reliability and Authority. Participants frequently (n=3) referred to the more device-like appearance of safety robots as looking professional, associating it with reliability and as a symbol of authority, especially in commercial districts and urban outdoor settings. They indicated that the appearance features of robots like Cobalt–such as its sleek and modern design, uniform colour scheme, and prominent sensors and camera configuration–enhance their perception as official safety devices. As P3 highlighted, *"The Cobalt robot is like a police station, signalling to individuals that they can approach it for assistance or as a point of contact."*

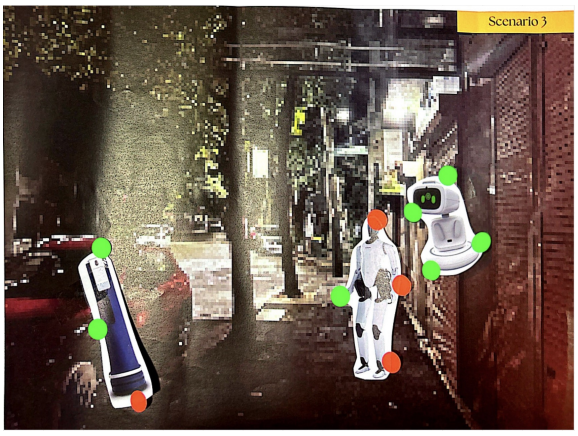

Fig. 4. Collage created by offline participants using robot stickers

4.1.2 Unobtrusive Surveillance. Referring to the more device-like appearance of the Cobalt robot, P1 and P5 emphasised the importance of the robot's ability to remain unobtrusive in public spaces. They suggested that a less conspicuous appearance allows the robot to blend seamlessly into the environment, with its discreet presence minimising direct interference with the public. Interestingly, they also speculated on a more discreet robot potentially increasing its monitoring effectiveness by reducing visibility to potential wrongdoers. As P1 pointed out, a discreet design enables the robot to *"secretly look out for the attackers"* while *"protecting the civilians."* This was somehow unexpected as previous deployments of safety robots were marketed towards providing physical deterrence. On the other hand, our participants suggestions may also demonstrate how existing technologies (e.g., hidden security cameras) may influence imagination about the role of emerging technologies such as safety robots.

4.1.3 Impact of Anthropomorphic Design on User Perception. Opinions on the design of safety robots vary. Some participants found the animal-like design comforting, particularly for its appeal to *"pet lovers"*. Conversely, others expressed concerns about its effectiveness in aggressive situations, suggesting that it might not deter criminals and could even provoke them (P3). Additionally, there were concerns that highly anthropomorphic robots might induce fear, especially in low-light conditions, where they could be mistaken for a threat. For instance, P3 commented on another participant's collage depicting the integration of CyberOne into a night scene (see Figure 4), *"I think if it (safety robot) has human shapes, it will scare people at night."*

4.2 General Expectations towards Safety Robots

Based on participant-generated use cases from the storyboard activity, we summarised women's expected roles for safety robots in the following four categories.

Safety Companion and Portability. Participants expressed a desire for safety robots to serve as companions in situations where they felt insecure or were walking alone. They valued the robots' ability to provide both physical and psychological support, including ongoing verbal communication and the ability to identify potential dangers (P1, P5, P6). The idea of a portable and discreet companion, such as AIBI, was particularly appealing because it offered continuous companionship without drawing unnecessary attention or disrupting others. However, some concerns were raised about the small size of such robots potentially limiting their effectiveness in emergencies (P3). Overall, this type of accompaniment was seen as boosting confidence and courage when navigating spaces perceived as threatening (P1, P4).

Safety Monitor and Rapid Response. The role of safety robots as proactive monitors was highlighted by participants, who emphasised the importance of these robots in detecting, patrolling for potential threats, and reacting quickly to ensure effective protection (n=6). Participants envisioned these robots as comprehensive inspectors capable of scanning environments and addressing concerns about blind spots when walking alone. They also stressed that the robots must be agile and responsive, with the ability to react swiftly to emerging threats. For instance, P5 highlighted the importance of robots like CyberOne (as shown in Figure 4) to *" take action very quickly to protect other passengers."* in critical situations. While P4 noted the expectation for AIBI to make a loud sound and potentially inform nearby authorities if a stranger approached and she felt unsafe.

Safety Information Communicator. Participants (n=5) also envisioned safety robots playing a critical role in emergency situations by recording video evidence and alerting authorities. They expected the robots to document incidents, notify users of dangers, and send alerts to nearby individuals and emergency services. For example, P6 described the robot's role as reporting incidents with the sounds "Di, Di, Di..." and communicating with the owner and others nearby, which would help in rapidly addressing dangerous situations.

Deterrent Robotic Police Officer. Participants (P2, P3, P5) anticipated that safety robots could function as a deterrent against potential criminal activity, thereby fostering greater public trust. Specifically, participants (P2, P3) consistently expressed the expectation that safety robots could operate as extensions of law enforcement in particular contexts. To this end, P3 proposed that these robots could serve as visual markers to discourage criminal behaviour (as illustrated in Figure 5). Regarding their official qualities, participants speculated that outfitting the robots in uniforms similar to those of police officers could enhance their perceived authority and increase public trust in their role.

Service-orientated Safety Information Carriers. Participants generally supported the idea of future service-oriented safety robots beyond improving community safety and speculated about the potential of robotic technology providing assistance in cases of domestic violence. However, concerns were raised about privacy risks, data collection, and the potential for increased costs due to diversifying services. They highlighted the need for balancing the benefits of improved service efficiency with the protection of personal information (P3, P7, P8).

Apart from these more general use cases, participants further envisioned how robots might respond in high-threat scenarios, which differs from their needs during threat prevention. They speculated on the robot's ability to effectively address threats and facilitate communication for emergency assistance.

4.3 Adaptive Integration and Collaborative Roles

It was noteworthy that most participants had difficulties to explicitly articulate how safety robots should be integrated into urban life in terms of larger scale deployment and feasibility. One participant demonstrated in the storyboard activity that safety robots could enhance their situational adaptability and functional perception through clothing. In reference to the storyboard material depicting a University campus, she suggested for the robot to don academic gowns in this context to blend into the environment and switch roles if needed (Figure 5, 1). For the fourth image in Figure 5, she suggested multiple safety robots collaborating within a specific area: these robots were sketched to assist in crowd management by networking with other robots and coordinating with electronic screens, thus disseminating information to the public. This adaptive and collaborative approach highlights the potential for safety robots to function dynamically across various urban settings and to meet specific situational demands.

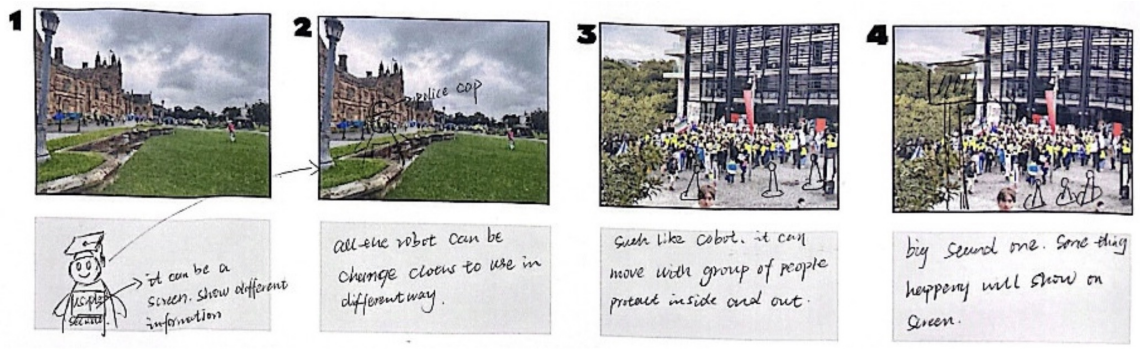

Fig. 5. Storyboard created by offline participant

4.4 Attitude of Future Deployment and Potential Concerns

In the focus group, we also asked participants to list their concerns about the future deployment of safety robots and to reconsider their attitudes toward the use of robotic technology for public safety.

The first focus group exhibited a highly positive attitude, viewing the potential implementation of safety robots as a positive development. They also believed that service-oriented roles could significantly enhance the utilisation of safety robots. In contrast, the second group displayed a more neutral stance. Notably, one participant pointed out that privacy issues, including data security, are challenging to address. She emphasised that the inability to resolve these privacy concerns would likely hinder the widespread acceptance and adoption of safety robots. When we further inquired whether making data processing by robots more transparent would affect her current stance, the response was negative. This reluctance is largely unrelated to the technical aspects of processing and interaction but stems from a broader human bias and mistrust toward unfamiliar technologies [18]. As she remarked, *"They can hide something that you don't know. I feel like I have to be very good at computer science to be able to trust them."* (P9)

5 DISCUSSION

5.1 Adaptive and Service-oriented Roles of Safety Robots

Our findings contribute to and extend previous research on urban robots [53], highlighting the necessity for safety robot designs to consider the varying role requirements across different urban scenarios. The roles and tasks of safety robots

should be adaptable based on situational context and spatial configuration, ensuring both flexibility and reliability. For instance, women participants in our study expressed a preference for safety robots to maintain order in high-density areas, whereas in dark and less populated spaces, they favoured robots acting as companions, engaging in interaction and addressing potential threats. Additionally, our study suggests that safety robots can use their design features to provide visual cues to the public, thereby facilitating role transitions and signalling. This adaptability in design can enhance the practical efficiency of safety robots in various urban settings.

Furthermore, our study reveals a trend towards integrating service-oriented functions into future safety robots, such as emergency service requests and systems for interfacing with human entities to provide comprehensive support and convenience. This approach not only ensures safety services for women but also enables other community members to seek assistance or access services, thereby contributing to a safer and more inclusive environment that maximises overall community benefits.

5.2 Design Considerations & Prioritisation

This study reveals differences in participants' preferences for the design and appearance of safety robots, highlighting the varying priorities users have for robot characteristics in different environments. For instance, in a dark alley, some participants found humanoid robots reassuring and effective at deterring potential criminals, while others feared these designs might induce anxiety. This underscores the nuanced balance between "deterrence" and "reassurance" in safety robot design, which affects both effectiveness and public acceptance. Prioritising appropriate design features can optimise robot functionality in specific contexts, aligning with the needs of the majority of women.

Moreover, concerns regarding the broader impact of robots suggest that future research should involve a wider range of stakeholders, including community members [27] and policymakers [35]. Engaging with these groups can provide a more comprehensive perspective, ensuring designs effectively deter crime while also making the public feel safe and comfortable.

However, the varying preferences among our participants towards safety robots, could also suggest that still many uncertainties exist about the role and understanding of these technologies in safety applications. Furthermore, people's imagination of how safety robots should be designed may be biased by existing technologies [43]. It is therefore advisable to consider a holistic approach towards improving women's perception of safety in public spaces, including the interplay of robots with existing methods in crime prevention. Building on the current application of environmental design to achieve natural surveillance for crime prevention, safety robots can be reimagined as key alternative roles in crime prevention. For instance, as demonstrated in the study by Marius et al. (2021), urban robots have the potential to exhibit engaging and interactive behaviours within existing environments [20]. Safety robots could utilize prominent and appealing visual cues to create a relaxing atmosphere for women, while also conveying a sense of "being present and responsive" to citizens through instant vocal or visual communication. This design can effectively mitigate feelings of "isolation and helplessness" that women may experience upon entering a space, thereby revitalise public spaces and increase perceived safety in a subtle manner.

5.3 Balance Design and Physical Integration

Our research highlights the effect of the robot's physical presentation on environmental integration. A recent study on robots in general indicate that their deployment in urban environments can diminish a sense of belonging and increase anxiety among residents [37]. Feedback from participants in our study suggests that the design of robots must be closely aligned with their deployment environment to mitigate unnecessary tension or resistance within the scene.

For instance, in shopping malls, a more unobtrusive and cautious design should be adopted to avoid drawing excessive attention or causing discomfort to visitors. This underscores the importance for designers and policymakers to consider the gradual introduction of robotic technologies into urban spaces, ensuring that they do not intrude upon or dominate the urban landscape [37].

5.4 Limitations and Future Work

Based on feedback from women participants in this study, most held a positive attitude towards future safety robots. However, Enz et al. [12] suggests that people's attitudes can be shaped by experience and knowledge. Given that the participants were predominantly from a campus environment, their frequent exposure to technology likely made them more receptive to safety robots. Besides, the recruited participants in our study were predominantly from Asia and Oceania, which may limit the generalizability of the findings to broader populations. Future research should include diverse cultural backgrounds and age groups to gain a broader understanding of women residents' attitudes towards safety robots.

While our focus group activities provided valuable design insights, it also had limitations. Compared to immersive interactions with virtual reality technology, relying on paper images and scene descriptions may only partially capture the real-world context, potentially leading to biased or incomplete perspectives. Future studies should incorporate high-fidelity prototyping, such as virtual reality or field studies, to validate and refine design considerations and observe interactions with women residents more closely.

6 CONCLUSION

Motivated by the safety perception inequalities arising from gender differences, this study investigated the potential of urban robots in promoting social equity. We presented preliminary findings on women's attitudes and expectations toward safety robot technology, clarifying their needs for the roles and qualities of safety robots in situations where they feel unsafe in urban environments. Our research offers initial guidance for the design of safety robots in urban settings, indicating potential research directions of safety robots towards more inclusive urban environments.

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