Shift-Integrated mHealth for Safety-Critical Work: Formative Evaluation of a Police Wellbeing App

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Designing mHealth tools for police personnel requires attention to irregular schedules, interrupted breaks and operational unpredictability. This paper reports a qualitative formative usability evaluation of a shift-integrated wellbeing app developed for police shift workers. Seven police personnel with 8–33 years of shift-work experience and three Human-Computer Interaction (HCI) experts participated in a 90-minute guided demonstration and focus group evaluation. Transcripts, facilitator notes and expert usability observations were analysed thematically. Findings show that the usability of a shift-integrated wellbeing tool was shaped by four occupational conditions: operational unpredictability, fragmented interaction windows, institutional trust concerns and shift-linked wellbeing needs. These conditions generated formative design requirements across four areas: operational adaptability, low-burden interaction, learnability and discoverability, and trustworthy schedule-aware wellbeing support. The paper proposes a formative analytic framing of the shift schedule as usability infrastructure in policing and related shift-work settings, describing how shift schedules may shape the timing, adjustability and perceived relevance of wellbeing support when operational work disrupts planned routines.

Keywords: *shift-integrated mHealth; formative usability evaluation; police shift work; occupational mHealth; workplace wellbeing; schedule-aware wellbeing support.*

1. INTRODUCTION

Digital health tools are often designed around wellbeing behaviours such as hydration, nutrition, sleep, physical activity and stress management (Baumann et al., 2025). For police personnel working shifts, these behaviours are tied to unstable work time because shifts may rotate, breaks may be delayed, duties may change at short notice and recovery periods may be limited. General digital wellbeing tools may therefore be poorly suited to this context if they assume stable routines, predictable breaks or fixed times for support (Swanston et al., 2021; Mehra et al., 2023). This supports the case for schedule-aware wellbeing tools, but only if the shift schedule is treated as more than a calendar feature. If it is used only to display work time, the system may miss the conditions that determine when support is useful, feasible or disruptive.

This matters particularly in policing shift-work contexts, where rotating shifts, incident response and limited recovery windows are common (Barth et al., 2022; Violanti et al., 2017). Occupational digital wellbeing is an important Human-Computer Interaction (HCI) concern because workplace wellbeing tools must fit the conditions under which shift workers can notice and act on support. For police shift workers, the issue is not only that they experience wellbeing risks, but that the organisation of work time shapes whether support is usable in

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practice. A wellbeing reminder may be appropriate in principle but unusable if it arrives during an incident, a missed break, or a period when the worker cannot safely attend to a device. Usability therefore depends on the context of use, including availability during the shift, workload, institutional trust, and the user's ability to act on support when it is delivered (ISO, 2018; ISO, 2023).

Prior work shows that police workers want mobile health (mHealth) tools aligned with irregular shift patterns (Swanston et al., 2021), and that shift management can improve the relevance of police wellbeing applications (Mehra et al., 2023). However, these studies do not provide a detailed usability account of what changes when the shift schedule becomes the organising structure for wellbeing support. In this setting, the schedule is not only a record of work time; it shapes how support is timed, how reminders adapt to missed breaks, rota changes and scheduling disruptions, and how data trust is negotiated in a workplace wellbeing tool.

This study addresses that gap through a qualitative formative usability evaluation of the shift-management component of a shift-integrated wellbeing app developed for police shift workers. Rather than assessing health or wellbeing outcomes, the study examines how shift scheduling affects the usability of schedule-aware wellbeing support. The app was informed by co-design research with police staff, which identified the need for simplified schedule creation and reusable shift patterns (Mehra et al., 2023).

This study was guided by two research questions:

(i) What formative usability requirements emerge when wellbeing support is organised around the shift schedules of police workers?

(ii) How do occupational conditions in policing shift work shape the evaluation and interpretation of shift-integrated wellbeing tools?

This paper contributes a formative analytic framing of the shift schedule as usability infrastructure in police mHealth. The framing describes how schedule information may shape the timing, adjustability and interpretation of wellbeing support under unstable working conditions.

2. BACKGROUND

2.1 Shift work, wellbeing, and temporal constraints

Shift work is common in high-stress occupations such as healthcare, public safety, and emergency services, and is associated with fatigue, poor nutrition, cardiovascular disease, sleep disturbance, post-traumatic stress, anxiety, and depression (Barth et al., 2022; Costa, 2010; Caruso, 2014; Violanti et al., 2017).

In policing, wellbeing behaviours such as eating, hydration, activity, sleep preparation, and recovery are shaped by shift start and end times, break availability, shifts that extend beyond their planned finish time and rest periods. Fixed notification windows and assumptions of uninterrupted attention are therefore poorly suited to this context (Swanston et al., 2021; Mehra et al., 2023; Ayorinde et al., 2025).

Policing provides a useful case for examining these work-time constraints because it includes varied shift-based roles, including frontline, call-handling, dispatch, and supervisory work. Across these roles, personnel may respond to incidents, manage high workload, adapt to short-notice changes, work across locations, and make decisions under pressure (Queirós et al., 2020; Kalkanis et al., 2023; Ayorinde et al., 2025). Formal rota patterns exist, but operational demand can still alter break timing, duty location and the rhythm of work.

2.2 Digital scheduling, mHealth, and the integration gap

Digital scheduling tools and mobile health (mHealth) tools usually address separate problems. Scheduling tools represent work time, while mHealth tools support behaviours such as sleep, hydration, nutrition, mood, stress and physical activity. In shift-based occupations, this separation can reduce the relevance of wellbeing support because the behaviours being supported depend on the schedule itself: when work begins and ends, when breaks are possible, when duties take longer than planned and when recovery can occur (Buckingham et al., 2019).

Buckingham et al. (2019) suggested that digital wellbeing tools commonly focus on areas such as nutrition or mental health while overlooking operational scheduling needs. Similarly, prior research argues that mHealth tools for irregular occupations such as policing need to adapt support to changing shift patterns (Mehra et al., 2023). In HCI terms, this is not only a functional problem but an interactional one: scheduling and wellbeing support must fit into existing work activities rather than impose additional coordination work (Bardram, 2009).

In shift-integrated wellbeing tools, schedule information becomes part of the interaction context. This connects with just-in-time adaptive intervention (JITAI) research, where support is tailored to the user's current state and context (Nahum-Shani et al., 2017). Shift timing, break windows, rest days, work locations and pattern changes may shape the

relevance and timing of wellbeing support. The resulting design challenge is that the system must use schedule data while preserving flexibility, user control and trust.

Trust and data autonomy are recognised concerns in health technology adoption (Müller et al., 2023), while discoverability remains a distinct issue in interaction design (Mackamul et al., 2024). Their combined role in workplace digital wellbeing tools linked to shift schedules remains under-examined. Swanston et al. (2021) established that UK police workers wanted mHealth tools aligned with shift patterns, while Mehra et al. (2023) evaluated a multifunctional police wellbeing prototype in which shift management was later added as a design improvement. These studies establish the relevance of shift-awareness for police wellbeing tools, but they do not explain how scheduling, wellbeing support, and trust interact when the shift schedule becomes the basis for deciding when and how support is delivered.

2.3 Behaviour change and digital wellbeing support

Behaviour-change frameworks offer theoretical grounding for why schedule integration matters beyond convenience. The COM-B model proposes that behaviour occurs through the interaction of capability, opportunity, and motivation (Michie, van Stralen and West, 2011). In policing shift work, opportunity is especially unstable because the ability to act on wellbeing intentions is constrained by operational demand and shift timing, not motivation alone.

Behaviour-change techniques such as self-monitoring, action planning, feedback, and prompts or cues depend on whether users have a realistic opportunity to act (Abraham and Michie, 2008; Michie et al., 2015). This is consistent with cognitive behavioural accounts in which behaviour is shaped by the interaction between individual, emotional, and environmental conditions (Beck, 2020). In policing shift work, the shift schedule is a key environmental condition. Shift-integrated wellbeing tools should therefore treat the shift schedule not only as a display feature but as contextual input that shapes when prompts are timely, when self-monitoring is realistic, and when support should be withheld.

2.4 Usability in software quality and HCI

Usability concerns effectiveness, efficiency and satisfaction within a specified context of use, while ISO/IEC 25010 also includes learnability, operability, user assistance and error protection (ISO, 2018; ISO, 2023). In shift-integrated tools, operability concerns whether schedules can be amended as operational work changes, while discoverability is distinct from learnability because users must first notice a function before learning to use it (Grossman et al., 2009; Mackamul et al., 2024). A guided demonstration and focus group were therefore used to identify formative requirements before independent and field-based evaluation (Hartson et al., 2003).

2.5 The Blue Light Guardian application

Blue Light Guardian is a mobile wellbeing application developed for police personnel and other shift-based emergency workers. The application includes shift management, hydration, sleep, nutrition, daily journal, wellbeing resources and notification functions. The shift-management component allows users to create reusable shift patterns, record shift start and end times, add breaks, edit individual shifts and view schedules in a calendar.

The wider design intention is for schedule information to provide temporal context for wellbeing support: a user's shift start time, break period, night shift or rest day may be used to inform when hydration, nutrition, sleep or recovery prompts are delivered. The present study evaluated only the shift-management component. It did not evaluate the independent use of the wider wellbeing modules, the effectiveness of wellbeing prompts, or health outcomes. The wider application included notification functionality, but automatic schedule-triggered prompts linked to recorded shifts were not demonstrated or evaluated in this study.

3. METHOD

3.1 Research design

This study used a qualitative formative usability evaluation (Hartson et al., 2003) to examine the shift-management component of the Blue Light Guardian application (Section 2.5), evaluated as a working, interactive prototype rather than a deployed production system. The evaluation combined guided exploratory demonstration, focus group discussion, facilitator observation, and HCI expert input.

This approach was selected because the application was at an early stage and the aim was to identify usability strengths, contextual barriers, expectations, and design refinements before summative or field-based evaluation.

A focus group format was used because it allowed participants to compare shift-work experiences, challenge assumptions, and generate design refinements within a constrained evaluation session (Rabiee, 2004; Krueger and Casey, 2015).

Combining police personnel and HCI experts allowed operational experience and interaction-design critique to inform the formative interpretation; the risks of this combined format are discussed in Section 7.1.

3.2 Participants

Ten participants took part in the evaluation: seven police personnel and three HCI experts. Purposeful sampling targeted participants with direct experience of rotating shifts, shift management, or HCI evaluation, while convenience sampling reflected the practical availability constraints of police shift workers (Palinkas et al., 2013; Campbell et al., 2020).

Police participants were recruited from a UK police organisation and included call handlers, dispatch coordinators, supervisors, and former frontline police officers. All had direct experience of rotating shifts, with professional experience ranging from 8 to 33 years. The HCI experts were recruited from a UK university and contributed specialist perspectives on usability, design clarity and interaction quality. The sample was appropriate for the study's aim, which was to surface actionable usability requirements rather than estimate prevalence or produce summative usability metrics (Faulkner, 2003; Hwang and Salvendy, 2010).

The dataset included recorded discussion, transcript data and facilitator observations, providing both operational evidence about shift-work realities and interface-level evidence about the prototype.

3.3 Procedure

Data collection was guided by a semi-structured discussion guide designed to gather usability feedback while allowing participants to raise issues spontaneously. The evaluation was conducted as a 90-minute facilitated focus group session. At the start of the session, the facilitator introduced the study, obtained informed consent, and clarified key concepts, including "shift cycle," "shift pattern" and "shift schedule."

The application was projected for group viewing, and participants were guided through onboarding, shift-cycle creation and editing, reusable patterns, break and note entry, reset and delete functions, and calendar views. Confirmation dialogs and tooltips were shown to prompt discussion about error recovery, terminology, visual clarity and trust in data handling.

Police personnel and HCI experts participated in the same session. The session was used to identify formative design requirements rather than to measure task completion, error rates, or usability scores. Throughout the demonstration, participants were invited to comment on what worked, what was unclear, what was missing, and how the tool might fit into day-to-day policing.

3.4 Data collection

Data were collected through audio-recorded focus group discussion, transcribed verbatim, and facilitator field notes. The field notes captured non-verbal cues, hesitation, clarification requests, peer agreement and points where participants appeared uncertain about terminology or functionality.

Quotations reported in Section 4 and Appendix A are labelled by source where this can be established: PP for police participants, HE for HCI experts, and FN for facilitator-note observations that were not direct quotations. Source labels are inferred from quotation content rather than a formal speaker-diarised transcript; quotations without a clear content-based indicator are left unlabelled. Labels are kept at the role level rather than assigned individual participant numbers, since with only seven police participants and three HCI experts from a single organisation, numbered codes risk becoming identifying when combined with the role descriptors in Section 3.2.

3.5 Data analysis

Reflexive thematic analysis was used to identify patterns across transcripts and facilitator notes (Braun and Clarke, 2006, 2019). Coding was initially inductive and focused on participants' descriptions of application use, work routines, scheduling expectations and usability concerns. Two researchers familiarised themselves with the data and developed provisional codes separately to reduce the risk of premature closure on codes. Coding agreement was not treated as a validity criterion; instead, interpretive differences were discussed reflexively to refine candidate themes.

During analysis, comments were interpreted according to their evidential role. Police participant comments were used primarily to identify occupational needs, contextual constraints and expectations for real-world use. HCI expert comments were used primarily to interpret interface-level issues such as discoverability, terminology, visual hierarchy and error protection. Facilitator notes were used to contextualise verbal feedback by recording hesitation, clarification requests, agreement and observed confusion.

3.6 Reflexivity, trustworthiness, and ethics

The study received institutional ethical approval from a UK university, and informed consent was obtained before data collection began. The researchers were involved in app development, facilitation and analysis, meaning the evaluation and analysis were not fully independent from the design process. This involvement was treated as part of the

analytic context, with reflexive discussion used to examine how design assumptions and familiarity with the application may have shaped facilitator prompts, participant responses and theme development.

Trustworthiness was supported through triangulation across transcripts, facilitator notes, police participant feedback and HCI expert critique. Consistent with reflexive thematic analysis, we did not calculate inter-rater reliability because coding was treated as an interpretive process rather than a procedure for producing coder consensus (Braun and Clarke, 2019). Credibility was supported by retaining traceability between quotations, analytic keywords, themes and design implications. Transferability was supported by describing participant roles, occupational context and the evaluation setting (Nowell et al., 2017). Combining police personnel and HCI experts in one session also created a risk that expert observations could shape later discussion or reduce the visibility of individual end-user perspectives, discussed further as a limitation in Section 7.1.

3.7 AI use declaration

AI assistance was used only for grammar, readability, checking for repetition, and sentence-level editing during manuscript preparation. It was not used for idea generation, research design, data collection, data analysis, interpretation of findings, citation selection, or reference verification. All AI-assisted edits were reviewed and approved by the authors before inclusion.

4. RESULTS

Four occupational conditions shaped the usability requirements identified in the analysis: operational unpredictability, fragmented interaction windows, institutional trust concerns and shift-linked wellbeing needs. Ten themes were organised under these conditions. Figure 1 maps the conditions and themes to the resulting design implications, while Appendix A (Table A1) provides quotation-to-theme coding examples. Section 4.5 explains how the occupational conditions interact.

4.1 Operational unpredictability requires flexible and recoverable scheduling

Operational unpredictability was central to participants' feedback. A usable system needed to accommodate variable breaks, day-level changes, recurring modifications, annual leave, multiple work locations, and errors. Flexibility and control therefore emerged as core requirements: participants expected tools to support real-time adjustments, personalised scheduling, and safe error recovery in ways that reduced cognitive burden and maintained confidence.

4.1.1 Adaptive break management

Breaks were not experienced as fixed or predictable.

> "Today I might have my break at 12, but tomorrow I might not have [a] break until one or two o'clock; it varies so much" *(PP)*

Other participants described breaks as assigned by departments and altered by operational demand. Break entries and related prompts should therefore be optional, editable and responsive to delayed or missed breaks.

4.1.2 Flexible schedule management

Participants required the ability to edit individual days without disrupting an entire shift pattern, and to make recurring changes without redoing a full pattern:

> "If every second Tuesday I'm on a late, I don't want to redo the whole thing." *(PP)*

Participants therefore required single-day, date-range, recurring-exception and whole-pattern editing.

4.1.3 Integrated shift calendar with annotations

Participants wanted the shift schedule to work as a personal calendar or diary:

> "My shift plan became my calendar: I would like to just add a comment in there." *(PP)*

Participants also wanted locations, duties, reminders and personal notes attached to individual shifts, particularly when working across sites.

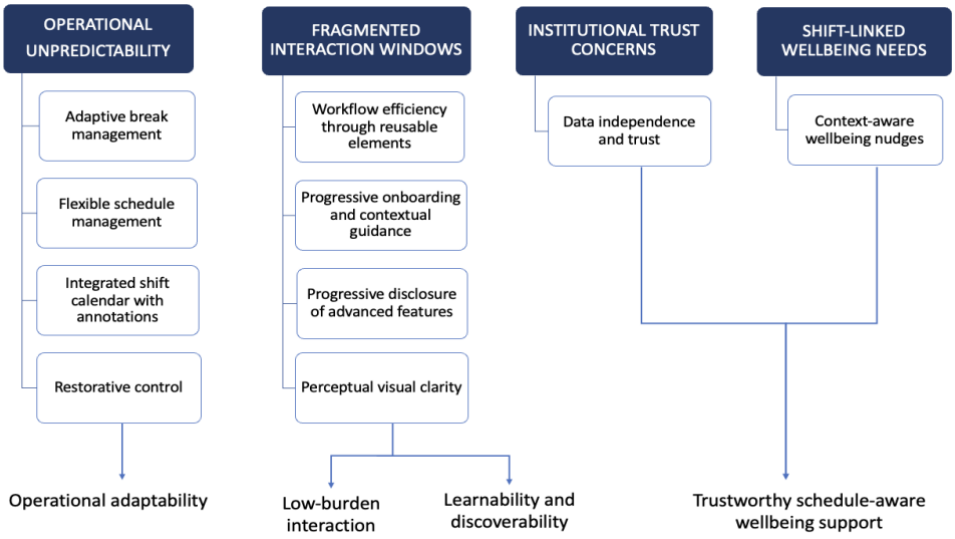

Figure 1. *Occupational conditions and usability themes mapped to the resulting design implications.*

4.1.4 Restorative control

Participants valued mechanisms that allowed them to correct mistakes, reset schedules, or start again:

> "But as you get back in and notice you have made an error, you can go in, change it, and make an adjustment."

Restorative control mattered because participants were managing complex schedule data that could affect later wellbeing prompts. Confirmation dialogs were valued, but participants' comments suggest that destructive or bulk actions also require post-action recovery options. In this context, restorative control does more than prevent errors; it encourages confidence when users manage complex and personally important schedule data.

4.2 Fragmented interaction windows require low-burden learning, reuse, and rapid comprehension

Police shift workers may interact with digital tools during short, interrupted, or cognitively loaded moments. Participants therefore valued features that reduced setup time, supported quick comprehension, and made advanced functionality easier to discover.

4.2.1 Workflow efficiency through reusable elements

Reusable shift patterns were viewed as one of the app's strongest features:

> "Once you've set it up, the pattern, you don't have to keep doing it again."

This reflects a key requirement for shift-integrated wellbeing tools: users should not have to repeatedly recreate complex schedules. Reusable templates reduce repetitive input, lower the risk of error, and support efficient interaction (Figure 2). Participants appreciated preloaded templates of common police shift patterns because these lowered the initial setup burden and helped them understand how the app could fit existing routines.

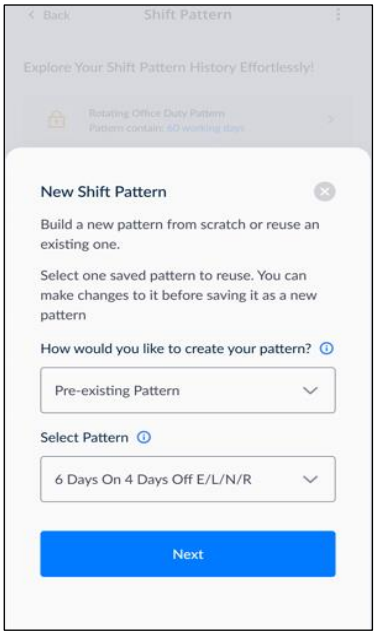

Figure 2. *Reusable shift patterns screen.*

4.2.2 Progressive onboarding and contextual guidance

Participants found the tool easier to understand once terminology was explained:

> "It's good you've explained what shift cycle and shift pattern mean. I've never used anything like this before." *(PP)*

Once terminology was clarified, participants described the workflow as self-explanatory and easy to complete. Learnability depended on clarifying the system's conceptual model. The terms "shift cycle,"

"shift pattern," and "shift schedule" were not automatically meaningful to all users, but once explained, the workflow became clearer (Figure 3). Although the app included tooltips, participants' need for terminology clarification suggests that contextual guidance should be more prominent through onboarding, inline hints, and just-in-time explanations.

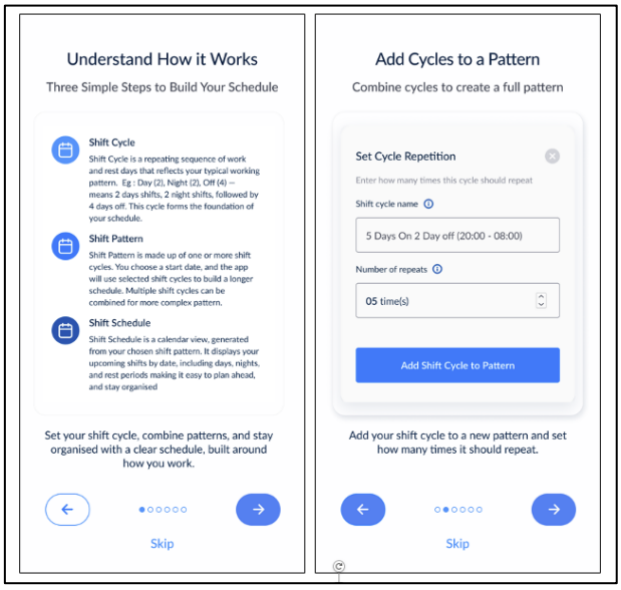

Figure 3. *Onboarding guidance for shift-cycle, shift-pattern and shift-schedule concepts.*

4.2.3 Progressive disclosure of advanced features
Some useful advanced functions were initially hidden. Participants only discovered features such as batch deletion or deleting from a specific date after demonstration:

> "That's really useful, but I wouldn't have found that unless you showed me." *(HE)*

Similar comments concerned date-specific deletion. Because these functions were demonstrated rather than independently discovered, the findings identify where clearer signposting is needed; they do not establish independent discoverability. This distinction is discussed further in Section 5.2.

4.2.4 Perceptual visual clarity
Visual clarity was important for rapid comprehension:

> "I like that the late shifts are one colour, I can see my month instantly." *(PP)*

Colour coding allowed participants to interpret the calendar quickly and distinguish shift types at a glance (Figure 4). This matters in short interaction moments because users may not have time to inspect detailed entries. Clear presentation of workdays, rest days, breaks, and shift types is therefore foundational for both scheduling and wellbeing support.

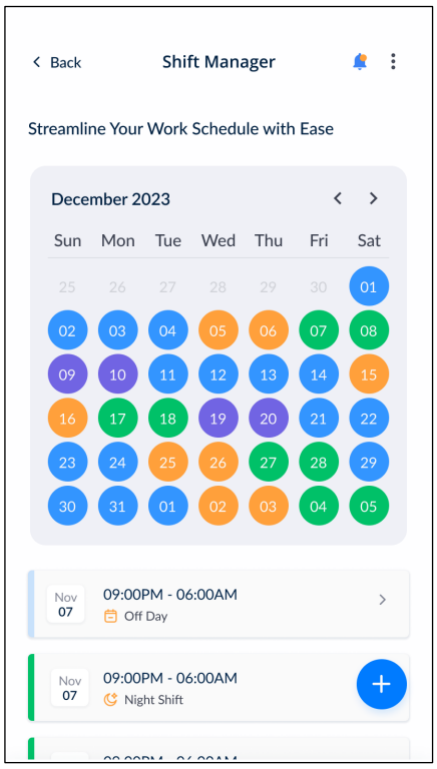

Figure 4. *Colour-coded schedule screen.*

4.3 Institutional trust concerns require data independence and transparent boundaries

Institutional trust emerged as a distinct usability issue. Participants valued the fact that the app was not linked to police systems:

> "it's good it's not linked to the police system; we wouldn't get it approved otherwise." *(PP)*

Participants also expressed discomfort about recording wellbeing information on employer-managed devices, while facilitator notes captured concerns about organisational access and surveillance (FN). Data independence therefore emerged as a usability concern, with participants preferring separation from official police IT infrastructure. Although supported by a limited number of explicit comments, the finding indicates that organisational data boundaries may influence willingness to use the application.

4.4 Shift-linked wellbeing needs require schedule-aware prompts

Participants considered schedule-linked prompting desirable and described how reminders should respond to actual shift timing:

> "If it knows my shift starts at 8, it should remind me at 8:15." *(PP)*

Comments about delayed breaks, variable shifts and operational disruption, together with facilitator-observed agreement (FN), supported a preference for schedule-aware rather than fixed-time prompts. However, no schedule-triggered notification engine was demonstrated in operation, so this finding represents a participant-stated design requirement rather than evidence of usability, acceptability or effectiveness.

4.5 Interaction between occupational conditions

The four occupational conditions were interconnected rather than independent. Operational unpredictability affected the accuracy of schedule information because breaks, locations and shift end times could change at short notice; inaccurate or outdated schedule information would then reduce the relevance of any schedule-linked wellbeing prompt. Fragmented interaction windows increased the need for rapid comprehension, reusable patterns and simple error recovery, since users could not rely on returning later to explore or correct the system at leisure. Institutional trust influenced whether users would enter the personal schedule and wellbeing data required for personalisation in the first place: a technically capable schedule-aware system is of limited use if trust concerns lead users to withhold the data it depends on. Schedule-linked wellbeing support therefore depended not only on technical integration, but jointly on schedule flexibility, low-burden interaction, and confidence that personal information would remain outside managerial monitoring.

5. DISCUSSION

5.1 The shift schedule as usability infrastructure

ISO 9241-11 positions usability in relation to users, goals, resources and environments. Usability infrastructure was used as a formative analytic framing, rather than an established theoretical category. It describes how the shift schedule may shape when support is relevant, how disruption is managed and what forms of adjustability users require. In shift-integrated wellbeing tools, the schedule is therefore more than a record of work time: it forms part of the context through which effectiveness, efficiency, satisfaction and error recovery are experienced (ISO, 2018; ISO, 2023). This framing remains provisional and requires independent and field-based evaluation.

5.2 Usability under fragmented attention

Learnability and discoverability become occupationally situated when interaction occurs under fragmented attention. Police personnel may use the tool during short, interrupted or fatigued periods. Reusable templates, colour coding, tooltips and progressive disclosure can reduce what users need to remember, infer or correct during these limited interaction windows. Learnability and discoverability are related but distinct usability concerns because users must first notice a function before they can learn to use it effectively (Grossman et al., 2009; Fraser et al., 2016; Mackamul et al., 2024).

The guided demonstration supported comprehension once features were shown, but it cannot establish whether users would have noticed or understood them independently. These findings should therefore be interpreted as formative evidence that some functions currently require clearer onboarding and signposting, rather than as evidence of achieved discoverability or learnability.

5.3 Institutional trust as a usability condition

Institutional trust is an interactional condition of usability in workplace wellbeing tools. Participants' responses show that a tool may be technically functional but still unusable if workers believe personal wellbeing data could become visible to managers, occupational health, HR or police IT systems. This finding extends work on trust and autonomy in health technology adoption into the employment context, where data visibility can affect whether users feel safe recording personal wellbeing information (Huckvale et al., 2015; Müller et al., 2023). Trust is not only established at sign-up; it must be reinforced at the points where sensitive data are entered.

This concern is particularly relevant in policing. Bell, Palmer-Conn and Kealey (2022) found that police personnel associated mental-health disclosure with possible career harm and reported limited trust in supervisors and occupational-health confidentiality. Participants in that study also avoided having occupational-health appointments displayed on shared work systems because this could reveal information intended to remain private. These findings help explain why participants in the present study valued separation from police IT infrastructure. Even where organisational access is not technically available, uncertainty about whether wellbeing information could influence performance, occupational-health or fitness-for-duty decisions may discourage disclosure.

Wider workplace research reports similar concerns. Perceived workplace surveillance has been associated with reduced autonomy, privacy violation and poorer worker wellbeing (Glavin, Bierman and Schieman, 2024). Research on workplace wellbeing-sensing technologies also shows that workers may have limited control over whether data are collected and how they are used, making visible

and ongoing explanations of access and purpose important for meaningful consent (Chowdhary et al., 2023).

Trust therefore depends on more than encryption or a formal privacy policy. The application should make data boundaries visible at relevant entry points by explaining what information is collected, where it is stored, whether it is linked to organisational systems, who can access it, and how users can delete or export their records.

5.4 Schedule-aware prompts require user control

Schedule-aware prompting should be understood as controlled automation rather than simple contextual delivery. Participants valued prompts linked to shift timing, but their accounts also show that policing work is too unpredictable for rigid prompting logic. Prior work on routine-based reminders suggests that prompts anchored to existing routines can be more meaningful than generic timer-based alerts (Stawarz et al., 2014). Interruption research also shows that prompts delivered at inopportune moments can increase frustration and cognitive cost even when the content is relevant (Adamczyk and Bailey, 2004; Iqbal and Bailey, 2010). These findings extend a recognised JITAI challenge to a safety-critical occupational setting. JITAI research already recognises that a moment may be appropriate for support without the person being able to act on it, reflected in the concepts of opportunity and receptivity (Nahum-Shani et al., 2017). In policing, this challenge is more pronounced because a recorded break may be delayed, a shift may overrun, or an incident may make a prompt inappropriate. Schedule data should therefore be treated as one contextual input for timing support rather than as a guaranteed trigger, consistent with the postponement, suppression and correction requirements described in Section 6.1. The following design implications translate these occupational conditions into concrete requirements for shift-integrated wellbeing tools.

6. DESIGN IMPLICATIONS

The findings suggest four design implications for shift-integrated wellbeing tools: operational adaptability, low-burden interaction, learnability and discoverability, and trustworthy schedule-aware wellbeing support. Fragmented interaction windows contribute to both low-burden interaction and learnability because short and interrupted use affects how quickly users can complete tasks and whether they can notice and understand available functions.

Implications concerning wellbeing-prompt integration are based on participants' stated expectations rather than observed use (Section 2.5) and should be treated as provisional.

6.1 Design for operational adaptability

Shift-integrated wellbeing tools should support schedule changes at different levels, including individual days, date ranges, recurring exceptions and full shift patterns. Breaks should be optional, movable and capable of reflecting department-assigned or operationally delayed timings.

Police shifts may overrun because of incidents, arrests, handovers or staffing demands, while breaks may be reassigned or missed. Schedule-aware support should therefore allow users to postpone, suppress or reschedule prompts without requiring them to reconstruct the full rota. Per-shift annotations should also allow users to record locations, duties, reminders or personal notes. This may be particularly useful for personnel working across stations, control rooms or temporary deployments.

Error protection should flag scheduling conflicts such as overlapping shifts, missing rest days or unusually long or overnight shifts.

Operational adaptability matters specifically for an mHealth tool: an inaccurate break time is a minor inconvenience in a generic calendar, but here inaccurate schedule information could cause hydration, nutrition or recovery prompts to be delivered at times that no longer reflect the user's actual work pattern.

6.2 Design for low-burden interaction

Shift workers may use digital tools during short, interrupted or cognitively demanding moments. Interaction should therefore be fast, legible and easy to recover from. Reusable and preloaded occupational shift templates should allow users to apply common patterns without repeatedly entering the same information. Familiar examples may also help new users understand how the scheduling system works.

The interface should support rapid comprehension through colour-coded shifts, clear monthly views and consistent labels. Destructive or bulk actions should provide confirmation and a brief post-action undo option.

Low interaction burden has particular importance in policing because the application may be used alongside incident response, dispatch or other demanding work. A prompt that requires sustained attention may compete with operational tasks. Wellbeing support should therefore be brief, easy to dismiss or postpone, and designed to minimise unnecessary interruption.

6.3 Design for learnability and discoverability

Shift-integrated tools should make unfamiliar scheduling concepts understandable without external training. Terms such as “shift cycle,” “shift pattern” and “shift schedule” should be explained through progressive onboarding, tooltips, examples and first-use walkthroughs.

Advanced features should be visible without overwhelming users. Batch editing, date-specific deletion, recurring changes and other high-value functions could be introduced through contextual prompts, guided tours or persistent help. A help function containing a short glossary and frequently asked questions could keep terminology accessible after initial onboarding.

This matters particularly under short or interrupted use: if users cannot quickly locate editing or exception controls, schedule information may go uncorrected, undermining the accuracy on which later wellbeing support depends.

6.4 Design for trustworthy schedule-aware wellbeing support

Wellbeing prompts should be linked to actual shift timing rather than generic daily routines. Prompts should respond to shift start times, breaks, rest days, night work, recovery periods and user preferences. They should remain editable, postponable, pausable or dismissible because operational demands may override planned routines.

Data independence matters because police personnel may be concerned that personal wellbeing information could become visible to supervisors, HR, occupational health or police IT systems, or be interpreted in relation to performance or fitness-for-duty decisions. Even where such access is not technically available, uncertainty about data boundaries may discourage honest self-monitoring. This concern is heightened because the application is an mHealth tool rather than a generic scheduling system: alongside shift data, it may process information about sleep, mood, stress, alcohol use and recovery, which may constitute special-category personal data under Article 9 of the UK GDPR, as supplemented by the Data Protection Act 2018.

The application should therefore explain what information is collected, where it is stored, whether it is linked to workplace systems, who can access it and how users can delete or export their records. This information should be available during onboarding, in settings and at relevant data-entry points rather than only in a general privacy policy.

7. LIMITATIONS AND CONCLUSION

7.1 Limitations

The sample was small and drawn from one UK police organisation, so the findings should be treated as context-specific rather than generalisable across all policing or emergency-service settings.

As discussed in Section 5.2, the guided demonstration did not allow independent assessment of discoverability, learnability, task completion, efficiency or error rates. Participants' positive responses following explanation should therefore be interpreted as facilitator-supported comprehension rather than evidence of independent usability.

Potential relevance beyond policing rests on shared conditions such as rotating schedules, interrupted breaks and unpredictable workload. These conditions are also reported in other shift-based emergency occupations, such as emergency medical services (Barth et al., 2022). However, this does not establish empirical generalisability to those occupations.

Combining police personnel and HCI experts in one group may have shaped later discussion or reduced the visibility of individual end-user perspectives; distinguishing evidence sources improves transparency but does not remove this limitation. Participant type could not be verified from recordings or transcripts for every quotation, so source categories were applied only where the quotation's own content provided a reasonably confident indicator; uncertain quotations were left unattributed.

Only the shift-management component was evaluated. The study did not directly observe the use of hydration, sleep, nutrition or other wellbeing functions, nor did it test schedule-triggered notifications during live shifts. Implications for schedule-aware wellbeing support should therefore be treated as provisional design implications derived from participant discussion rather than evidence of operational effectiveness. The study cannot determine whether schedule-aware prompts would be helpful, intrusive, postponed or ignored during real shifts.

Future work should combine independent task-based usability testing with longitudinal field evaluation, consistent with staged approaches in which formative findings inform later summative and operational assessment (Hartson et al., 2003).

7.2 Conclusion

This study identified formative usability requirements for a shift-management component

intended to support schedule-aware wellbeing in policing. The findings indicate that operational unpredictability, fragmented attention, concerns about organisational data visibility and shift-linked wellbeing needs shape how users interpret and manage shift information. These conditions interact rather than operate independently.

The study also identified functions that currently depend on facilitator explanation and therefore require clearer terminology, signposting and onboarding. It does not establish independent usability, operational acceptability or wellbeing effectiveness.

The next evaluation stage should assess whether users can create, amend and recover schedules without guidance, whether terminology and advanced functions are independently discoverable, whether privacy boundaries are understood, and whether schedule-linked prompts remain relevant and acceptable during live shifts. Independent task-based testing should precede longitudinal field evaluation, consistent with staged formative-to-summative approaches (Hartson et al., 2003).

Consistent with the formative framing proposed in Section 5.1, the shift schedule is best understood at this stage as a candidate usability infrastructure for policing mHealth tools: a provisional analytic lens supported by the present findings rather than a validated theoretical claim.

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APPENDIX A. QUOTATION-TO-THEME CODING EXAMPLES

Table A1. Coding links between participant quotations, analytic keywords, usability themes and source (PP: police participant; HE: HCI expert; —: not attributable from content alone; see Section 3.4). FN does not appear here, since this table indexes direct quotations only; facilitator-note observations, which are by definition not quotations, are cited inline in Section 4 (e.g., Section 4.3).

S/N	Quotation	Analytic keywords	Usability themes	Source
1	*"Today I might have my break at 12, but tomorrow, I might not have break until one or two o'clock, it varies so much."*	*break times, variability, unpredictability, flexibility*	Adaptive break management	*PP*
2	*"Some department your meal break is given to you each day, its mapped out on what's happening on that day"*	*daily planning, break, assigned daily, operational-context break*	Adaptive break management	*PP*
3	*"my shift plan became my calendar…I'd like to just add a comment in there."*	*calendar integration, annotations, notes, personalisation*	*Integrated shift calendar with annotations*	*PP*
4	*"If you're working in different police stations for different shifts, it would be really helpful."*	*location, multiple workplaces, context-specific note*	*Integrated shift calendar with annotations*	*PP*
5	*"Would you be able to use this in a diary sense as well?"*	*diary use, record keeping, personal notes*	*Integrated shift calendar with annotations*	—
6	*"for me, my shift plan I used previously became my calendar, because our calendar is so different. And then, in comparison to another calendar, you're just having to compare notes all the time. Go back into this one, then go back into the other to make notes"*	*note-taking, calendar integration, shift planning.*	*Integrated shift calendar with annotations*	*PP*
7	*"You could go in individual days and change just that day, this is essential for us."*	*day editing, individual changes, essential, operational flexibility*	*Flexible schedule management*	*PP*
8	*"If I've taken one of my four-day shifts in a row as annual leave, I want to reflect that in my shift plan without changing the whole pattern."*	annual leave, partial edit, reflect changes, flexibility	*Flexible schedule management*	*PP*
9	*"So, you could go in individual, let's say they change my pattern for the next three months every second shift. I was working a late instead of an early. I just have to individually go into each of these dates and changes that from early to a late shift, that makes sense"*	Flexibility, recurring shift, adjustment, shift pattern changes, schedule management.	*Flexible schedule management*	*PP*
10	*"If every second Tuesday I'm on a late, I don't want to redo the whole thing."*	*recurring change, inefficiency, partial pattern edits*	*Flexible schedule management*	*PP*
11	*"That's really useful, but I wouldn't have found that unless you showed me."*	*hidden features, discoverability, reliance on guidance*	*Progressive disclosure of advanced features*	*HE*
12	*"I didn't realise you could delete from a certain date onwards."*	*delete, lack of visibility, discovery through demo*	*Progressive disclosure of advanced features*	—
13	*"I didn't realise you could batch delete, that's really useful."*	*batch delete, feature discovery, usefulness*	*Progressive disclosure of advanced features*	—
14	*"Once you've set it up, the pattern, you don't have to keep doing it again."*	*template reusability, efficiency, timesaving*	*Workflow efficiency through reusable elements*	—
15	*"I like that the late shifts are one colour… I can see my month instantly."*	*colour coding, visual clarity, quick recognition*	Perceptual visual clarity	*PP*
16	*"If it knows my shift starts at 8… remind me at 8:15."*	*context-aware reminders, wellbeing prompts, shift-linked prompts*	Context-aware wellbeing nudges	*PP*
17	*"It's good it's not linked to the police system… we wouldn't get it approved otherwise."*	*personal device, IT restrictions, privacy, adoption*	*Data independence and trust*	*PP*

18	*“Sometimes you just want to start fresh.”*	reset, wipe, start over, control	Restorative control	—
19	*“But as you get back in and notice you have made an error, you can go in, change and make adjustment”*	error correction, regain control, adjust mistakes, schedule adjustment, error recovery	Restorative control	—
20	*“Very self-explanatory once you understand the terms.”*	*terminology, clarity, self-explanatory after guidance*	Progressive onboarding *and* contextual guidance	—
21	*"It’s good you’ve explained what shift cycle and shift pattern mean… I’ve never used anything like this before."*	*terminology explanation, onboarding, new user learning*	Progressive onboarding *and* contextual guidance	*PP*