

Towards a Socio-technical Understanding of Police-citizen Interactions

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Abstract. The growing uptake of technology in policing provides the opportunity to revisit police-citizen interactions. This paper explores police-citizen interactions from a socio-technical systems perspective, drawing on community policing in the HCI literature, as well as the experience of both citizens and the police. For the latter, we report on a qualitative study with 29 participants including citizens, parish councillors, and police officers in England. Our findings use a socio-technical systems lens to highlight both social and technological challenges in police-citizen interactions, leading to several implications for practice and HCI design. These challenges include those arising from divergent viewpoints, power, and information imbalances between stakeholders, and technical systems that duplicate functionality or limit police-citizen interactions. Thus, our work contributes to extending HCI insights into the socio-technical infrastructure of policing contexts, and a better foundation for future research in the design and use of technologies to enhance community policing.

Keywords: Socio-technical system, Community policing, Policing, Police-citizen interaction.

1 Introduction

Good police-citizen relations are imperative to effective law enforcement [1, 2]. In the policing literature, there is an increasing interest in exploring how to improve police-citizen relations [3]. One way to encourage positive police-citizen interactions is through community policing [4], which engages community resources to achieve more effective crime control and prevention [5, 6]. The widespread uptake of community policing has provided a great opportunity to explore routine day-to-day police-citizen interactions [1, 7]. However, scholarly attention has often focused on negative, police-initiated enforcement interactions with citizens [8], e.g., traffic stops because the

‘*negative bias theory*’ [9] was found in policing that negative police-citizen contacts have stronger influences on citizen satisfaction with police than positive interactions [10]. Moreover, comparatively less research examines routine police-citizen interactions from a socio-technical systems perspective. This is a significant gap, given that law enforcement agencies increasingly adopt digital technologies to engage with the public and the critical importance of effective citizen-police relations in modern societies.

The socio-technical systems (STS) approach is a framework for analyzing complex systems of actors, social and technological elements, and the interactions between them [11, 12]. This approach emphasizes the intersecting effects of social actors and technological systems rather than the sole reliance on technological solutions [13]. It is widely recognized that STS could lead to a system that is more acceptable to stakeholders [14]. Policing is a complex socio-technical system due to dynamic interactions between people, procedures, policy, technology, and the environment. In this paper, we examine the police-citizen interactions based on Davis et al.’s STS framework [12], which comprises six pillars: *people, goals, culture, infrastructure, process, and technology*.

The aim of this research is to understand and highlight some of the perceived constraints in current routine police-citizen interactions from a socio-technical systems perspective. We conducted semi-structured interviews with 29 participants, including citizens and law enforcement stakeholders from England, to explore how they interact with police or citizens. To the best of our knowledge, this is the first work that empirically explores routine police-citizen interactions in a socio-technical way. The contributions of this paper are twofold: firstly, our work extends HCI insights on socio-technical infrastructure by applying an STS approach to the policing context; secondly, we propose implications for both practice and HCI design in the field of community policing. We conclude by discussing the added value of applying a socio-technical approach in understanding and identifying both challenges and opportunities for HCI researchers to explore the police-citizen interaction sphere.

2 Related Work

For this work, we draw from prior research on police-citizen interaction, community policing, and socio-technical systems.

2.1 Police-citizen Interaction

Police-citizen interaction is used interchangeably with police-citizen contact [15] or encounter [16]. Law enforcement has been reformed since the 1970s [17] to ensure more effective, accountable, responsive, and ‘soft’ policing [18]. As policing shifts gradually towards community policing worldwide [5, 19], citizens have been provided with greater opportunities to actively take part in crime prevention and investigation [5]. Voluntary community participation [20, 21] assisted the police by reporting incidents or suspicious individuals face-to-face or via phone lines, such as through schemes like Neighborhood Watch and StreetWatch [22], and citizens are increasingly taking

shared responsibility for security in their local communities [5]. One typical example is the citizen-initiated ‘cyber-vigilantes’ who assisted the police in the criminal investigation of the Boston Marathon bombing in 2013 [23].

Existing work in police-citizen interaction has mainly explored factors affecting negative police-citizen interactions or encounters [24] and how to alleviate the negative impacts [25] on police legitimacy and accountability [26]. For example, Bottoms and Tankebe [27] argued that the normality of police as the ‘powerholder’ and the community being ‘policed’ was still implicitly rooted among the police and citizens. As Radburn et al.’s study [28] suggested, police interactions with citizens are not purely interpersonal but inter-group in nature, because police distinguish themselves as a ‘powerful social group’ and the boundary between ‘us’ and ‘them’ were rhetorically constructed [16]. On the other hand, Famosaya’s work [8] highlighted the importance of the overlooked ‘ordinary’ police-citizen encounters, such as language and actions on a daily basis, which may transform into extraordinary negative interactions. The increased dynamics in police-citizen interactions resulting from the ‘soft’ policing shift provide opportunities to re-examine the routine, day-to-day actions and experiences of police-citizen interactions.

2.2 Community Policing Technology

The definition of Community Policing (CP) is still vague [29] due to the undefined concept of ‘community’ in various contexts. One popular definition is coined by Myhill [30]: “*Community policing is the process of enabling the participation of citizens and communities in policing at their chosen level*”. There are three agreed features of CP: police-community collaboration, problem-solving approach, and organizational decentralization [30]. The collaboration between police and external stakeholders is at the core of community policing [31]. Traditional community policing often emphasizes the visibility of police officers and the availability of citizen initiatives within local settings. Information and communication technology (ICT) has altered police practice [32] and the way citizens interact with the police [33].

HCI scholars have investigated how technology can facilitate community policing activities. New styles of community policing are often characterized by their adoption of mobile technologies [34, 35] and social media platforms [36–38]. For example, Kadar et al. [35] designed a crime prevention system allowing people in Switzerland to report crimes in real time, and residents could be notified about the safety of their neighborhood through other community members’ reporting [34]. Brush et al. [39] integrated home surveillance cameras to build a digital neighborhood watch network. In the Netherlands, citizens-initiated WhatsApp neighborhood crime prevention groups [36] to patrol neighborhoods digitally. Similarly, South African citizens initiated a Community Policing Forum on Facebook, which increased community cohesion [37]; and Erete [38] found that online community participation in America improved community engagement in the real world.

The practical implementation of community policing varies based on the socio-demographic characteristics of the community and of police organizations [40]. The most recent work by Erete et al. [41] has revealed the complexity of community policing in

violence prevention. Brewster et al. also claimed that there is no one-size-fits-all approach that could be implemented in diverse socio-cultural and socio-economic contexts [42]. The effectiveness of community policing has been a matter of considerable debate in practice. For example, researchers highlighted its success in crime reduction [43], violence prevention [44], and increasing social control [36], while other work pointed out issues and limitations, e.g., Terpstra [19] suggested that the police are only enthusiastic about initiatives that are likely to provide a source of useful information. Thus, it is imperative to consider social factors, as well as organizational and policy factors when deploying technological interventions.

2.3 Socio-technical Systems

Socio-technical systems (STS) theory was first proposed by Trist [11] in 1960 to describe a coal mining system, which consists of complex interactions between people, machines, and the environment. Socio-technical systems thinking is now widely used as a philosophy to understand complex systems [14] where non-technological factors are intertwined with technological issues.

Researchers have proposed several potential frameworks of socio-technical systems. Ottens et al. [45] proposed an STS model with three elements (*actor, social elements, and technological elements*). Leavitt proposed a diamond organizational model [46] which consists of four interactive components (*people, task, structure, and technology*), Challenger and Clegg [47] further extend the diamond model into a hexagon model by adding more social elements: *people, goals, processes, culture, technology, and infrastructure*. In the hexagon model, *people* work within a physical *infrastructure* with *culture*, using a range of *technologies* and tools via *processes*, to achieve a set of *goals*. People have knowledge, skills, values, awareness, attitudes, and needs; where *culture* refers broadly to the shared values, norms, and beliefs of a group of people. The application of the hexagon model has been demonstrated in novel domains, e.g., crowd event management [48], environmental sustainability [12], and digital sterilization [49].

Inspired by Davis et al.'s work [12, 47], we deploy a socio-technical systems framework as the theoretical underpinning to analyze and understand existing police-citizen interactions, which is an open system involving interactional dynamics between the police and citizens [13]. We present findings based on the first-hand knowledge and experience of front-line police officers, victims, witnesses, parish councillors, and Street Watch volunteers. To ensure equal consideration of social, technological, and organizational aspects, we first outline each element of the socio-technical systems hexagon model, followed by highlighting social and technological challenges.

3 Methodology

The study was conducted between September and December 2019 at multiple sites. We completed semi-structured interviews with 29 participants (11 males and 18 females; age range 24-60; median age 38) in 11 sessions, which include both individual interviews and pair- or group-based discussions (see Table 1). The rationale behind the

different number of participants in each session is to keep people of similar role in a group to reduce both hierarchy and power issues [50]. In England, police officers are ranked from low to high with different legal power and responsibility as follows: Police Community Support Officers (PCSO), constable, sergeant, inspector, chief inspector, superintendent, chief superintendent, assistant chief constable, deputy chief constable/commander, and chief constable¹. There are also civilian roles working for the police force, such as forensic investigator/coordinator and control room call handler. The participants included 12 citizens from semi-urban areas in England (7 witnesses or victims, 5 parish councillors, with two citizens also having StreetWatch [22] experience), 1 prosecutor, and 16 police officers from two police forces in England. The study was approved by our Institutional Review Board in accordance with standard practice. Participants were given the option to withdraw their participation at any time. The citizen participants were recruited through campus-wide emails and noticeboards, with the criteria of having experience interacting with the police. The police participants comprised (PCSOs), police officers, and one leader from three police forces in England, recruited through the Centre for Policing Research and Learning at the Open University. All citizen participants were interviewed at the same place on campus, while we visited police stations and a control room to conduct group or individual interviews and observations with the police participants.

Table 1. Participant code and stakeholders' roles.

Participant code	Stakeholder's role	Participant code	Stakeholder's role
P1	Prosecutor	P15	PCSO
P2	Police officer & Witness	P16	PCSO
P3	Citizen – Victim, Witness	P17	PCSO
P4	Citizen – Victim	P18	Police officer
P5	Parish councillor	P19	Police officer supervisor
P6	Parish councillor	P20	Police officer
P7	Parish councillor	P21	Deputy Commander
P8	Parish councillor	P22	Citizen – Victim
P9	PCSO	P23	Citizen – Witness
P10	PCSO	P24	Citizen – Victim, volunteer
P11	Police constable	P25	Citizen – StreetWatch volunteer
P12	Police officer	P26	Citizen – Witness
P13	Civilian police officer	P27	Social media police officer
P14	Parish councillor, Street-Watch volunteer	P28	Contact resolution officer
		P29	Contact resolution officer

Each participant was first asked to introduce their experience with the police or citizens. They then played with the storytelling toolkit (Figure 1), pen, paper and post-it notes. In each toolbox, each type of item (e.g., building, character) has 10 copies of laminated pictures and were put into a small grid of toolbox, so participants could share the toolbox during the group session. We provided three same toolkit boxes in each

¹ https://lineofduty.fandom.com/wiki/UK_Police_Ranks

session so participants could work individually or in a pair if they have similar experiences and willing to work together. Our participants all chose to work on their individual storytelling to represent their own experience of police-citizen interaction and then shared their story in the session. Then a semi-structured interview was conducted, which asked questions about the challenges of interactions with the police/citizen, what technologies they used in these interactions, and the expected features of the technology that could help (see supplemental material for interview guide). These tangible toolkit materials were used because of their effectiveness in facilitating storytelling in a visual way, as well as catalyzing new ideas [51]. Each session lasted 1.5-2 hours, and each citizen participant was compensated with £10 in high-street shopping vouchers and travel costs. The interviews were audio-recorded and transcribed, and data analysis involved the standard inductive-deductive technique of coding [52], including literature-based codes, such as the six elements of the STS framework [12, 47], and codes emerging from data which were iteratively revised through weekly meetings between the first two authors and monthly meetings among all authors.



Fig. 1. The study setting (left) and storytelling toolkit (right).

4 Findings

Here we report the socio-technical systems perspective of routine police-citizen interactions by using the STS framework to provide a deductive structure for our analysis. This is supplemented by sub-themes that were developed inductively from the collected data, together with a set of socio-technical challenges.

4.1 Socio-technical Systems Perspective

This section describes six pillars of the socio-technical systems hexagon model [12] in police-citizen interactions: *people*, *goals*, *culture*, *infrastructure*, *processes*, and *technology* (deductive analysis) and emerging sub-themes (inductive analysis) (Figure 2).

People. Our findings indicate that police-citizen interactions involved groups of different stakeholders, e.g., citizens, law enforcement agencies (police force, Crown Prosecution Service (CPS), the court, etc.), third-party organizations, government, and volunteers who were actively involved in safety preservation in the community.

From our interviews, the police force in England was still hierarchically organized and centralized [P21]. There were both sworn police officers and civilians within the police organizational structure, and citizens could normally interact directly with the control room officers, civilian liaison officers, and frontline police officers including both police officers and Police Community Support Officers (PCSOs).

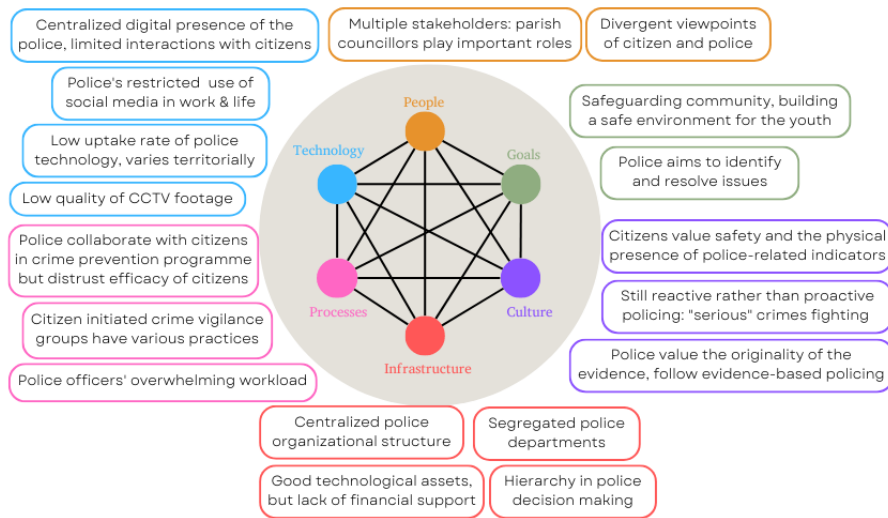


Fig. 2. Six pillars of the social-technical systems framework of police-citizen interactions.

Findings indicate that parish councillors played important roles in building bridges between residents and the police. Parish councillors are elected by residents as representatives of a local area, and they were trained to advise citizens towards appropriate support or assistance services. Additionally, they acted as a consultant to the local government agency (e.g., borough/city/county council) and the police [P8] and “registered” or “liaise” with the police [P23], and they served their local community voluntarily in all aspects (crime, health, education, housing, etc.) and mitigated the criminal activities. As P5 stated: “...say drinking outside, if I go and speak to them and ask them to move or bring a black sack and ask them to put the rubbish in there, they will do it for me. You get to their level to talk to them... Whereas, the police would turn up, they would not bring the black bag, they would not talk with them, they would be quite intimidating. Not always they get the results, or they will move then come back.”

Goals. The primary goal of police working collectively with citizens was to identify and resolve issues in the community. A key finding is that police and citizens had different expectations of police-citizen interactions. For example, regarding crime reporting, citizens expected a quick and easy process [P14, P22-23], options to be anonymous [P23], and reporting digitally without creating accounts [P24] or needing to disclose personal details [P22]. While police officers preferred to set up strict parameters for

what type of issues citizens could report to police officers [P18], with a great number of details used for verification, risk assessment, and making decisions [P12]. Citizens also expected to be able to follow up the updates on the reported case [P24]: *“it is a peace of mind... if you think what you're saying to them is going to get taken seriously and potentially lead somewhere and then get wrapped-up, that would be really useful to know. I think it would be promoting trust.”* However, the police officers were concerned about the workload [P18] and sensitivity of the crime data [P17] if providing an update to citizens. Although detailed information was preferred by the police, some police officers were also positive about anonymous reporting [P2]. Like PCSO P9 said: *“We'll always benefit from it [Crimestoppers], because having information is better than not having it at all.”*

Findings show safeguarding the community as the primary motivation for citizen volunteers' self-policing, especially for building a safe environment for youth development. The Street Watch volunteer P23 mentioned: *“I'm giving back to my community, it's building community spirit and a presence, that people can see and join in with. And I want people to look after everybody, I want to be able to let my kids out and not be afraid that they're going to talk to the wrong person.”* Parish councilors from the high-crime area initiated self-policing with similar motivations: *“We are safeguarding not only our friends and family, but the community as well. Because the kids are seeing the culture of seeing crime, seeing it as the norm, ignoring it, not talking to the police.”* [P8] Citizen participants also reported that the experience of policing during their youth influenced their attitudes in later life. As P6 mentioned: *“I found that really hard when I first started working as a community worker, because I was brought up not to speak to the police”.*

Culture. Citizen participants valued the safety and the presence of police-related indicators. Findings indicate that citizens believed that a higher physical presence of uniformed police officers could increase reassurance [P3, P6, P11, P13, P23-24] and being informed about police work and updated status could promote police transparency [P12-13, P23-24]. Our citizen participants also highlighted the positive atmosphere in a community, as P24 suggested: *“I feel like we need to trust our communities, not to spread the fear... good news would really promote nice things in the community... things we've solved or things that didn't happen in some way, because of community involvement.”*

Although the police force has transformed to incorporate community policing and built collaborations with a wider range of external stakeholders, the traditional policing norms were still valued in the mindset of the police. The ideology of crime-fighting and law enforcement was seen as ‘real’ police work made sworn police officers more respected internally than civilian officers [P12], and most police officers treated petty crimes as a lower priority than ‘serious’ crimes. As police officer P18 pointed out: *“we're interested in stuff...have to be a proper crime... we have priority crime and non-priority crime.”* This value is also reflected by citizen participants: *“I trust them [the police] to protect us in serious matters, but in daily life, it's not that helpful.”*

Originality of Evidence. Findings indicate the police's preference for first-hand detailed evidence, to enable law enforcement to use it in a court case. The enforceable evidence was collected by police officers via making written notes on notebooks [P19], interviewing citizens in person [P21], copying or recording the CCTV screen by using the body-worn camera [P12], and archiving and recording every communication with the citizen [P19]. For example, the control room officer P24 mentioned: "*if I'm doing something for evidential value what I'll do is screenshot or get a video recording of what I'm looking at and then save that.*" Another important finding that received little attention in previous work is that police treated the information from NGOs the same way as information from citizen witnesses, like police leader P21 claimed: "*...but it [Child-line] is still third-party because something is coming into them from a source that can't be verified.*" This reflects the police perspective on wanting enforceable evidence rather than information that could be construed as hearsay.

Infrastructure. Police forces in England provide services regionally, complemented by nationwide agencies and specialist units, such as the National Crime Agency. There are 43 separate police forces in England and Wales [45]. Each territorial police force has a slightly different policy on organizational structure, the responsibility of different roles, and shift work, etc. Different departments within a police force focus on different issues with one collective aim [P18]. For example, PCSOs complement the work of police officers by focusing on the lower-level crime and providing reassurance to the local community. Although our police participants were positive about technological artifacts, such as surveillance technologies, body-worn cameras, radios, digital note-taking devices, and ANPR (Automatic Number Plate Recognition) cars [P12], the real deployments of such equipment depend on each police force's financial infrastructure and situation. As police officer P18 explained: "*XX Police, as a force, is behind with technology compared to other forces. Like the mobile data terminals that my colleague has, that's just the norm for them. That's been around for ages. They can't believe that we're still writing on paper... it's all [about] money... and training...*"

Processes. We separate police practices from those of citizens and particularly focus on exploring the direct interaction between citizens and the police.

Police Practice. Police have adopted diverse tactics for interacting with citizens, such as foot, horse, bicycle, and car patrols; community meetings; community outreach programs; social media communication; encouraging the public to ring up for criminal activity [P11] and educating citizens via social media [P27]. However, the policing process was still mainly focused on reactive rather than proactive policing. The command-and-control strategy centralized public requests and triaged them to different departments. Police also collaborated with councils and third-party professionals or non-governmental organizations (NGOs) to interact with citizens. These collaborations allowed citizens to feel comfortable reporting certain issues to organizations that don't treat them as informants [P9]. For example, some police forces encouraged citizens to report through CrimeStoppers (an anonymous crime reporting charity) free landline or

online form. Police also referred citizens to certain NGOs with professional expertise [P20], e.g., Victim Support.

Findings show the police identified the value of residents' local knowledge and voluntary work. Some police participants attended Community Forums on a regular basis [P16]. Police participants acknowledged the benefits of crime prevention programs involving residents, e.g., Street Watch and Speed Watch, because the neighborhoods knew their local area well and could participate out of police working hours, which also freed up police time. As PCSO P17 said: *"They [residents] know the best time when the speeding is happening, if it's at 7 o'clock in the morning, we don't start until 8. So they can be there at 7. They can be there later if it's the longer days, if it's happening after 5 or 6 o'clock. So we want to get them involved as much as possible"*.

Although police officers were trained to use the National Decision Model [74] to guide their engagement with the public and in problem-solving [P12], there were leadership decisions made at different levels and ranks depending on the cases, as police officer P18 said: *"It just goes up through the rank structure. We all know what we can make a decision on and what we can't"*. For serious crimes, police officers usually consulted with relevant legal authorities (CPS in the UK) to make decisions. The process was opaque to the public, which made the police-citizen relations worse, resulting in the public tending to blame the police [P1].

Citizen Practice. Citizens have traditionally communicated with the police by telephone or by visiting a police station. Our findings indicate that citizen engagement was enhanced by digital technologies, including police websites, emails, social media, mobile applications (Apps), etc. Witnesses and victims reported criminal activities mainly by dialing both emergency and non-emergency numbers, and citizens were guided by the police to send multimedia files via social media chat [P29] or email attachments [P28]. Our citizen participants believed that the younger generation was more confident and willing to use the technology than the older generation [P3, P14]. Some special groups, e.g., the LGBT community [P11], were more confident interacting with the police digitally compared to interacting face-to-face due to privacy concerns. Street Watch volunteers were trained by the police first, and they reported to the police via email or telephone rather than interfering in the ongoing criminal activity themselves. Additionally, volunteers kept their personal information private by meeting in a public area [P25]. Citizens could make complaints about police misconduct [P11, P18], often by going through a formal police complaint procedure. However, citizens were creative when commending police officers [P21], e.g., by sending thank-you note or gifts [P2].

All our citizen participants knew about Neighborhood Watch. However, people perceived there were confusing and inconsistent practice depending on geographic locations [P4] or needed to be improved [P5-P8] to get the younger people involved [P7]. Another disadvantage mentioned by citizens was overwhelming email notifications sent by Neighborhood Watch: *"They send out a lot of emails, but I don't read it because a lot of them are a bit scaremongering, so I don't really get involved that much. Rather I keep a general eye on my street."* [P24]

Technology. Our findings show that the digital transformation promoted police forces to shift from a traditional recording system to a more digital criminal justice system [P10], and digital technology also provided another potential channel for citizens who are willing to interact with the police in different ways.

Centralized Digital Presence of Police. The visibility of police work has been increased by using police websites, emails, TV programs, body cameras, cell phone videos, and social media. Most police websites enabled citizens to report crimes; some police forces provided social media communication on a 9-to-5 schedule but monitored it on a 24/7 basis, like P21 mentioned “*social media fills the gap due to changing lifestyles*”. The police branches have their own local social media accounts, but with no power of taking a crime report.

However, our findings indicate that only a few police officers could interact with citizens directly in the digital world. Police officers from the control room could interact with the citizens via the official website and central social media accounts, such as Single Online Home website, Facebook, Twitter, Instagram, Snapchat, and email [P28, P29]. As PCSO P11 said: “*the police force is trying to keep everything centralized, trying to keep corporate [social media] accounts.*” Police officers with special training could access police Facebook and Twitter accounts [P16, P18, P21, P28, P29], but updating on social media or police websites was still done by the media team based at the police force headquarters [P12], because “*everything needs to be redacted*” [P19] due to the sensitivity of cases. Even the control room officers had to get permission to post on social media: “*As things are updated whoever is on duty will get it and then write a little brief about it, so that it can be developed in the back office.*” [P28]

Findings also indicate that third-party mobile Apps and websites were increasingly adopted by both citizens and police. For instance, citizens used Nextdoor [P9] and Bright Sky [P9]; patrolling police officers used Google Translate to communicate with foreign residents immediately [P10]; IP/location tracking service [P28] and email tracking website [P18] were used by police for work, and some police officers also created Nextdoor account for personal use to know about community [P16]. The police educated citizens by referring them to the official police resource website [P29], e.g., *Ask the Police* [75] and *fearless.org* [76].

Police Set Boundary of Social Media Use. Findings indicate the boundary between the working and personal lives of police officers [P21]. Police officers were not allowed to access the policing system on their work devices for personal purposes [P9, P11-12]. There are rules from the College of Policing around the personal use of social media: “*you shouldn’t identify yourself as a police officer*” [P21]. For instance, police officers were advised not to use their real names and profile photos on their private social media accounts [P20]. Police were very cautious about the balance between confidentiality and disclosure details, as police officer P20 said “*the freedom of speech, we don’t really have in the police, because you’ve got to be very careful of the consequences.*” [P20]

Police leaders were deeply concerned about the police’s capacity to adopt technology effectively. For example, a notable finding is that police forces set barriers to police officers when using social media: “*If I take pictures of a cadet session, I have to leave*

the session, email the pictures to my email account and then send it via the main PC in the office to Twitter. I can't just go like that and tweet it out anymore, I could do that three weeks ago. It's changed again... They want us to use technology, and then they put barriers in the way, because they get scared about us using the technology, like we can't be trusted." [P13]

Digital Citizen-Initiated Crime Vigilance Groups. The self-organized local social media groups were popular among residents. Other than mundane activities such as selling 2nd hand stuff, local Facebook groups also discuss and share information to directly support crime prevention and those affected by crime [P24]. As PCSO P11 reflected: *"it is all information that comes to and from the police. There are missing people on there..., road closures, burglaries that had happened in the local area to watch out for"* [P11]. Whereas WhatsApp groups were more private [P4, P14, P23], which set boundaries between different groups [P3-4, P25], e.g., community worker groups [P14], Street Watch volunteer groups [P25], self-organized minority ethnicity-based communities [P23]. One victim P3 showed concerns related to privacy and safety about using Facebook: *"the criminals sometimes are on them, so you have to be careful because then they're finding out."*

4.2 Socio-technical Challenges

The primary aim of using the socio-technical systems framework is to analyze and identify the potential problems and key challenges, which could be important contributions based on an empirical understanding of current police-citizen interactions. We now describe both social challenges and technological challenges, some of which are intertwined.

Social Challenges

Lack of Funding for Police. Findings highlight that lack of funding was quoted by police participants as the main reason why police forces could not fully be engaged with citizens. It directly led to a lack of police officers and a lack of devices, and some police forces adjusted the cost by combining the use of multiple systems [P18] and removing the costly but useful devices such as computers in police vehicles [P9, P12]. The front-line police officers believed that obsolete technologies put barriers to communicating with citizens and their routine work. For example, some police officers on patrols had to go back to the police station to make a record in the system and then go out again [P9-10, P16, P18], which causes frustrations [P19] and missing information [P16].

Findings show that citizens perceived either the absence of or a decreasing number of PCSOs/police officers patrolling in their community areas [P3-4, P6, P8]. Due to a lack of police officers, PCSOs sometimes were asked to attend emergency cases [P2]. And citizens also complained about the police's non-timely responses to non-emergency calls, which is costly [P5]. As police leader P21 said: *"The reality of today's policing and austerity is that we just don't have the number of officers we had in the*

past. Demands also have changed. Unfortunately, we don't have the luxury of people going out on foot patrol as they possibly did 15 or 20 years ago."

Divergent Viewpoints between Citizen and Police. We also identified several divergent viewpoints between the police and citizens, as well as among police departments. Firstly, the police encouraged community engagement, but they perceived that the efficacy of citizen participants and the quality of community work required improvements. For example, police only sent a warning letter to the speeding vehicle reported by a Speed Watch volunteer, as police officer P18 explained "*they [volunteers] are not trained enough to speeding [issues]. So we don't enforce it, because they are not trained enough for prosecution purposes.*" Our findings also indicate that police officers perceived that citizens could not differentiate between emergency and non-emergency issues [P2, P29], which may increase police workloads unnecessarily.

Secondly, public perception of the police was a big issue for the police. Policing was a black box for citizens, who perceived that the police only investigate serious crimes [P4, P23]. Moreover, residents in high-crime areas tended to lose trust in the police. They thought the police were unresponsive to their reports or needs, so they stated that the police were useless [P5]. These factors led to a reduced willingness to report suspicious activity [P8]. Furthermore, the public often overestimated the crime levels of their local areas, and these perceptions were difficult to change, even with police and city council reassurances [P21].

Finally, although police departments aimed to solve the problem collectively, there was a lack of communication and mutual understanding among police departments [P19]. As police officer P18 said: "*We're quite segregated. Sometimes it's hard trying to build those relationships. Paths don't always cross and when it does, it's not for very long...each team always says the other team is lazy...that's common. They don't know what that team does, I think that's normal*".

Technological Challenges. Findings indicate that the police used multiple, but unlinked, internal systems [P18], which cause repeated input work and inconsistencies in reference numbers used for a reported case [P27]. For example, when citizens reported using the Single Online Home website, police officers received an email and they had to manually create a record on the police force's internal system and send the new reference number back to the reporters by email.

Low Uptake of New Policing System. There are several barriers to technology adoption: costs, policy, human-associated issues such as technology literacy [P13] and technology adoption laggard [P24], and privacy concerns. Findings indicate the failure of some previous applications due to a low uptake rate. One example is First Evidence, a private charity-run crime reporting App mentioned by police officer P27: "*it was a non-mandated app, but all police forces were encouraged to take it. In five years, we got one report because there weren't enough followings, and people just didn't take it.*" Our findings show that citizens may not install and keep the App on their phones for just occasional use. Embedded digital evidence [P11-12] (e.g., GPSs) was helpful for the police to locate criminals more easily, but as it consumes battery power significantly and citizens tended to turn it off [P23].

Low Quality CCTV Footage. Apart from the local authority’s CCTV cameras, such as CityWatch, there were private, non-commercial CCTV cameras used by residents. Findings show that police officers emphasized the challenges of utilizing privately owned CCTV footage, due to poor quality [P9, P19], or police not having the relevant technical skills for the various brands of systems [P11]. As P9 put it: “*not every household has CCTV, it’s not necessarily always working, or they may not necessarily want to assist the police... they [the footage] will show that an incident has happened, but in terms of evidence in some situations they are not great. Trying to identify particular individuals or particular vehicles, it can sometimes be quite difficult*”.

Two Sides of Social Media. Findings indicate that social media is a double-edged sword. As a supplement to current channels of police-citizen communication, our findings show police participants were very positive about social media. However, police officers emphasized the careful use of social media [P16, P18, P21], as P18 suggested: “*social media’s been amazing. There are positives and negatives for it, but I think we’d struggle even more than we do now to engage with our community if we don’t have social media. Because it’s the new thing, everyone is on social media*”. On the other hand, citizens showed frustrations over the erratic pattern of police use of social media because citizens may not know that police forces had multiple accounts but only the central account could take the citizens’ crime reporting; secondly, citizens expected the police’s response on social media [P20]. Thus, the police “*had to put out a strong message: we are not responding to this as quickly*” [P28]. Some citizens were concerned about the fear spread by social media [P23-P24]. The abusive comments [P15, P20], especially to the police officers, and misinformation [P20] could bring substantial harm and mental health issues.

5 Discussion

Our exploration of police-citizen interactions with a socio-technical perspective extends HCI insights into socio-technical infrastructure in a policing context. Our work highlights several unaddressed socio-technical challenges faced by the stakeholders when interacting with each other. The police-citizen interactions can be viewed as a complex socio-technical system, with some aspects clearly social (e.g., police patrols); some aspects clearly technological (e.g., CCTV). We argue that both social and technological elements are fundamentally entwined [53], technology has impacts on the process and people’s awareness and its use is also affected by the organizational policy and goals. The interplay between social and technological challenges is also emphasized. For instance, due to a lack of funding, police forces have reduced the number of useful technologies or have to use multiple unlinked systems repeatedly to achieve their goals, which causes low efficiency of police work (e.g., PCSOs going back to the station to create a record; repeated input) and directly affect police’s community engagement and citizens’ perceptions of police presence and efficacy. The socio-technical challenges become more complex with dynamic interactions among people, between people and technology, and between people and the physical infrastructure. We propose

several implications for both practice and design based on key socio-technical challenges (Table 2).

Table 2. Implications for both practice and design.

Police-citizen interaction challenges	Practical implications	Design implications
Divergent viewpoints and expectations of police-citizen interactions	<ul style="list-style-type: none"> • The police provide clear rules and expectations for citizen participation. • The police offer training and community capacity building to citizens. 	<ul style="list-style-type: none"> • Technology needs to be configured to support the interaction expectations of citizens and the police. • Co-design activities involving different stakeholders
Useful but insufficient digital technology for police-citizen collaborations		<ul style="list-style-type: none"> • Need for crowdsourcing technology with different levels of citizen engagement [54].
Safety and privacy issues on social media	<ul style="list-style-type: none"> • Law enforcement practitioners and technology designers work together to help users to build online ethics 	
Imbalance of power and access to information between citizens and the police	<ul style="list-style-type: none"> • Police keep citizens in the loop to update the process regularly 	<ul style="list-style-type: none"> • Allow citizens anonymous reporting and limited personal information disclosure [55].
Lack of police officer's autonomy	<ul style="list-style-type: none"> • Bespoke training for improving police officers' proficiency in digital technologies. • Empower the front-line police officers to self-serve community 	
Boundary of technology use		<ul style="list-style-type: none"> • Call for further research and practical experience to further engage with this design space
Low uptake of new systems	<ul style="list-style-type: none"> • Establish information sharing protocols among multiple stakeholders 	<ul style="list-style-type: none"> • Design for integrating the police and other active collaborators

A key finding is that police and citizens had different viewpoints and expectations of police-citizen interactions, which leads to requirement conflicts between different stakeholders. As suggested by previous research [56], this is a crucial challenge when designing for community policing. The **hybrid online-offline presence and response** of police are highlighted by citizens; while the police, overwhelmed by massive workloads, expect first-hand, clear evidence and non-trivial suspicious activity with detailed information reported by citizens [19, 56]. It is suggested that the police should provide a set of ground rules and set their expectations clearly for citizens to participate, apart from supporting community capacity building [30] and training to raise awareness of law enforcement. With the social factors in mind, we argue that technologies need to be configured to support the interaction expectations of citizens and the police with a

balanced consideration. The co-design activities involving stakeholders with different needs together could be one approach to achieve this.

Findings indicate that current digital technologies utilized by citizens to collaborate with the police are useful but limited. We found that the younger generation, people who fear bureaucracy, and vulnerable communities (e.g., LGBT, sex assault victims) tend to interact with the police online, but cumbersome online crime reporting and erratic patterns of police online cause frustrations. Citizens are referred to as the ‘*eyes and ears*’ of the police [30], and current technologies only enable citizens to play the role of ‘*citizens as sensors*’ [57]. It suggests that crowdsourcing technologies [58] taking advantage of human intelligence, have the potential to optimize the configuration of citizen-police interactions. One promising direction is designing technology and policy that can facilitate richer citizen-led interventions at different levels from crime reporting, distributed analysis, and co-investigation to collective self-investigation, as described by Bandara et al.’s Citizen Forensics model [54]. Future work should investigate approaches to better design technologies to empower the mutually beneficial collaborations between the police, citizens, and other stakeholders in the field of community policing.

Our research supports the previous research on social media, as one of the socio-technical infrastructures [59], which has enabled and fostered interactions between the police and citizens in an alternative way. The capacity of social media in revitalizing neighborhood ties and civic engagement has been found in previous research [36, 38, 59, 60]. However, the social media engagement between the police and citizens tends to be limited due to the redacted collection and dissemination of information [23]. Moreover, there are concerns around the safety and privacy issues on social media, such as cyber harassment, misinformation, and fear spreading embodied via digital communications. We argue that it is the responsibility of both law enforcement practitioners and technology designers to help users to build appropriate ethics in the online communication space. HCI researchers and technology designers should work together to ensure that technology creates a positive atmosphere in the community.

Our findings also indicate the imbalance of power and access to information [61] between the police and citizens. Citizens could provide intimate knowledge of localized or specific communities online; however, they could not be able to check the results of reported cases online, and they perceived that they must give their contact details to the police. Police officers, vested with the coercive power of the state, are not just crime fighters [62], but also civil servants aiming to improve the quality of life for the community. Crime is a community problem, not a police problem. We acknowledge that some inequalities are necessary for the functioning of the social system [17], however, it is necessary for the police to update their progress regularly and keep citizens in the loop, which also increases transparency and trust [63]. We suggest that digital evidence collection with limited disclosure [55] could protect users’ privacy as well as support building digital trust between citizens and the police.

Findings also suggest a lack of autonomy for police officers. Specifically, hierarchically organized, and centralized bureaucracies and policies create barriers for police officers (especially at the bottom level) in their daily work. For instance, front-line police officers heavily relied on the control room and centralized social media team to get

or post the information online, and this might be due to the organizational nature of the police force [64]. And there are different levels of decision-making and approval needed from those higher up in the police's internal rank structure. The technical barrier of internal technology is another challenge, especially for older police officers. Autonomy is necessary to develop more intimate ties with their community [65]. We recommend providing bespoke training to help improve the officer's proficiency in using technologies (e.g., CCTV footage access skills) and to permit front-line officers to use the technology that they are comfortable with to self-serve the community.

In our view, community policing is desirable, because the nature of neighborhood crime and disorder requires collaboration among multiple stakeholders. The low uptake of third-party systems is because interaction with the police is not a must-have for some citizens. However, others (e.g., StreetWatch volunteers, and parish councilors) are self-motivated to actively safeguard their local community. In other words, citizens only want to be able to connect with the police when needed. Apart from designing citizen engagement incentive mechanisms, socio-technical design in community policing should focus on enhancing integration between the police, NGOs, councils, private security companies, and residents who voluntarily participate actively to address crime issues in their locality. Findings indicate that the police deal with NGO reports in the same way as citizen reports and contact police officers face heavy workloads to re-input the reported cases into internal police systems. It is suggested that establishing information-sharing protocols between different stakeholders, which effectively integrate information reported by the community and distribute it to the police for joint problem-solving, is vital for cross-organization collaborations.

Like physical spaces, digital interaction spaces should preserve some characteristics such as boundary and visibility, to avoid privacy violations. The public has become extremely sensitive to issues of privacy in our connected world, particularly when it comes to law enforcement. Understanding the boundaries set in technology use is necessary to empower citizens to act confidently and appropriately. For example, anonymous reporting is appreciated by citizens as an important feature, because citizens are concerned about being labeled as informants or fear reprisal especially if they report their neighbors [63]. The socio-technical design could assure sensitive victims in reporting without exposing them to potential harm (e.g., domestic violence). It is imperative to call for rigorous academic research and practical experience to further engage with this design space.

Finally, we believe the socio-technical systems approach has several potential benefits. First, STSs facilitate analyzing and understanding complex systems from a more holistic view. Second, they help identify what needs to improve for both practice and design. Third, STSs emphasize the joint optimization between social and technological elements [66], which guides HCI researchers to focus on a systems perspective rather than individual users. We argue that technology designers need to find a balance between social and technological requirements.

6 Limitations

Our interviews included participants from different locations and varying degrees of experience, including victims, witnesses, parish councillors, and StreetWatch volunteers. However, our sample is limited because we did not interview members of the public who had not ever interacted with the police and those who have been impacted by law enforcement actions by the police such as being taken into police custody [24]. Also, the police participants recruited were all White police officers from two England-based police forces, because police officers across England and Wales are mostly hired from the White ethnic group (93.1% at the end of March 2019) [1]. In addition, as evidence in psychology shows, it is possible that there were gaps between participants' actual experience and behavior and socially desirable answers [67]. However, our study still provides valuable socio-technical insights and empirical understandings of routine police-citizen interactions. It is acknowledged that our study was conducted prior to the COVID-19 pandemic, however, we think our findings are still valid as the nature of citizen-police interactions has not changed significantly since then [68]. Being aware of these limitations, future work could include the public and other ethnographic methods to reach stronger conclusions.

7 Conclusion

This empirical work investigates current police-citizen interactions from a socio-technical perspective, based on multi-sited interviews with 29 participants in England. This research provides a contribution of knowledge on both social and technological spheres of police-citizen interactions and key socio-technical challenges, followed by the practical and design implications, from which law enforcement practitioners and policy-makers could seek requirements for improvements. Our findings highlight some of the key challenges in achieving effective citizen-police interactions, ranging from the need to deal with divergent viewpoints together with imbalances in power and information held by different parties. Addressing these challenges requires technology that is designed to support the interaction expectations of citizens and the police and enables flexibility in the level of interaction between citizens and the police, including the ability to adapt the level of anonymity provided to citizens. Our work also extends the HCI recent insights on socio-technical infrastructure in a policing context. It is imperative to call for rigorous HCI research and practice to take a holistic view of social and ICT infrastructure for potential crowdsourcing technology solutions, also to explore the associated organizational, human, and technological challenges.

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