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Where There's Smoke, There's Fire: How Attempts to Reduce Unnecessary Police Traffic Stops May Backfire

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Where There's Smoke, There's Fire

Abstract

Digital decision-support systems are increasingly used in policing to promote more proportionate decision-making. However, their effects depend on how officers interpret the information these systems provide. This study examines how police officers interpret numerical feedback about prior police activity presented through MEOS (Mobiel Effectief Op Straat), a Dutch mobile policing application designed to support discretionary decisions.

Across two studies, we examined whether information about previous police checks and enforcement outcomes influenced officers' interpretations and simulated intervention decisions. Using virtual reality (VR) simulations and survey-based measures, we found no detectable effect of access to MEOS information on simulated intervention decisions. However, higher numbers of prior checks and registrations were consistently associated with greater perceived relevance and suspicion, more negative evaluations, and greater stated willingness to use the information when deciding whether to act.

The findings suggest that numerical indicators of prior police attention may acquire meaning beyond their intended function. Rather than being interpreted solely as evidence of limited enforcement relevance, higher levels of prior attention were associated with perceptions that a person or vehicle was more noteworthy and suspicious. These findings highlight the importance of understanding how digital information is interpreted within professional and organisational contexts when designing technological interventions in policing.

Keywords: police discretion, secondary sanctioning, ethnic profiling, nudges

Where There's Smoke, There's Fire

Introduction

Let us consider the following situation. A young man born in the Netherlands to Moroccan parents receives his driver's licence. His father, a successful and hard-working businessman, gives him the keys to his Porsche Cayenne. Proud of his new car, the young man enjoys driving it and the attention it attracts. During one of his first drives, however, he is stopped by the police. The officer explains that it concerns a routine check, inspects his licence and registration, and asks questions about the ownership of the vehicle and his occupation. The officer records the encounter and allows him to leave. Over the following weeks and months, similar encounters occur repeatedly. Each time, the justification is the same: a routine check. What initially appears incidental becomes increasingly difficult to interpret as random. The young man begins to wonder whether these encounters reflect chance events or whether he has gradually become perceived as a person of interest.

This example draws on an internal case analysis conducted within the Dutch police organisation in 2016 by the first author. The analysis examined administrative records concerning a young man who was queried in police databases 211 times within one year and physically stopped more than a dozen times. It reconstructed how previous entries in the police enforcement database (BVH) were used in subsequent encounters. These entries included not only formal enforcement outcomes, such as citations or arrests, but also observations and contextual notes. There is a widespread expectation among Dutch police officers that even seemingly irrelevant information may prove useful to colleagues in future encounters, and should therefore be recorded (Kleijer-Kool & Landman, 2016). Over time, repeated police contact thus generates additional administrative traces that become available for future encounters. Rather than simply documenting previous events, these accumulated records may influence how subsequent encounters are interpreted. Because this analysis was

conducted as an internal police study and has not been publicly published, the case is presented here as an illustrative example of a potential process rather than as evidence of a general pattern.

This process resembles what scholars have described as secondary sanctioning: prior police contact may acquire significance beyond the original encounter when accumulated records contribute to continued scrutiny or influence subsequent assessments (Boers et al., 2023; McGlynn-Wright et al., 2022). This raises an important question about the role of digital records in discretionary policing. If previous police attention becomes visible in later encounters, officers may not only consider what happened during previous checks, but also the fact that someone has been checked repeatedly.

This question is particularly relevant because police attention is not distributed equally across populations. Studies in Europe and North America have shown that members of ethnic minority groups are disproportionately subjected to police checks and may experience these encounters as more intrusive or punitive (FRA, 2017, 2019; Pierson et al., 2020; Voigt et al., 2017). These findings have contributed to broader debates on ethnic profiling, institutional bias, and police reform. Unequal policing outcomes may, however, not only result from decisions made during individual encounters. They may also be reinforced when previous police attention produces records that subsequently influence future assessments. Understanding how officers interpret accumulated digital traces is therefore important for understanding how technological systems may either reduce or reproduce patterns of disproportionate scrutiny.

One technological intervention designed to address concerns about disproportionate policing is the MEOS (Mobiel Effectief Op Straat) application used by Dutch police officers during routine patrols (Molenaar et al., 2020). Within MEOS, officers receive aggregated numerical

information about previous police contact associated with a vehicle or individual. This information includes (1) the number of database queries related to a licence plate or person, (2) the number of physical stop-checks, and (3) the number of enforcement registrations in BVH resulting from these encounters.

The intended function of these counters is to encourage more reflective decision-making and reduce unnecessary inequality in police stops. The underlying assumption is that repeated checks without corresponding enforcement outcomes indicate low enforcement relevance. Thus, a pattern of "many checks, few results" should signal that further intervention may be unnecessary. Providing officers with this information in MEOS was intended to act as a behavioural nudge towards more proportionate policing.

However, whether MEOS achieves this purpose depends on how officers interpret the information it provides. A high number of previous Checks could be understood as evidence that earlier interventions produced little enforcement-relevant information. Alternatively, the frequency of previous attention itself could become meaningful: repeated checks may signal that previous officers considered the person or vehicle noteworthy. In that case, the information intended to encourage restraint could instead contribute to further attention. The theoretical basis for this possibility is developed in the following section.

The present study examines whether numerical feedback about prior police attention operates as intended. We ask whether information indicating many previous checks and few enforcement outcomes encourages restraint, or whether repeated attention itself becomes a cue of relevance and suspicion. We distinguish between officers' interpretations of MEOS information and their simulated intervention decisions because these may represent different stages of discretionary decision-making.

We address this question in two studies. Study 1 is an exploratory pilot that examines how officers interpret different configurations of MEOS information and uses an immersive virtual reality (VR) scenario to explore potential behavioural effects. Study 2 provides a more controlled test by experimentally manipulating access to MEOS in the VR component and, separately, examining officers' interpretations of accumulated Checks and Registrations in a 2 × 2 within-participants factorial design. In the latter component, the order of the four MEOS configurations was randomised, while each participant evaluated all four combinations of Checks and Registrations. Across both studies, we examine whether prior police attention functions as a signal for restraint or instead acquires meaning as a cue of professional relevance.

We expect higher levels of prior Checks to increase perceived relevance and suspicion, even when they are accompanied by few enforcement Registrations. We further examine whether the interpretation of prior Checks depends on the number of Registrations. Finally, we assess whether access to MEOS information affects simulated intervention decision.

Theoretical framework: Numerical feedback as an interpretive cue in discretionary policing

Police officers routinely make discretionary assessments under conditions of uncertainty, incomplete information, and time pressure (Reiner, 2010; Van Maanen, 1978). Although these assessments are informed by formal procedures and professional knowledge, officers cannot rely on complete information or explicit probabilistic calculations in every encounter. Instead, they draw on experiential knowledge, pattern recognition, and contextual cues to assess whether a person, vehicle, or situation warrants further attention (Glaser, 2014; Kahneman, 2011; Tversky & Kahneman, 1974). The meaning of such cues is therefore not inherent in the information itself, but depends on how officers interpret it within their professional and organisational context.

Where There's Smoke, There's Fire

One consequence of decision-making under uncertainty is that salient or readily interpretable information may acquire disproportionate weight. Information that is repeated, easily recalled, or particularly noticeable can become a useful shortcut for assessing relevance (Taylor & Fiske, 1978; Tversky & Kahneman, 1974). In policing, this process may be especially consequential because officers routinely encounter ambiguous situations in which the relevance of available information is uncertain. Prior experiences with particular people, vehicles, locations, or behaviours may consequently become part of the contextual knowledge officers use when deciding whether further attention is warranted (Cankaya, 2012; Ikner et al., 2005).

This raises an important question about how prior police attention is interpreted when it becomes digitally recorded. A previous police encounter can be understood in at least two ways. It can be treated as information about what happened during that encounter—for example, whether an officer found evidence of an offence or took enforcement action. But it can also be interpreted as information about the attention itself: if a person or vehicle has been checked repeatedly, this may suggest that previous officers considered it noteworthy or relevant. In the latter interpretation, the number of previous encounters becomes a cue about professional judgement rather than merely a record of past activity.

Digital policing systems can make this second interpretation particularly salient. Unlike ephemeral encounters, digitally recorded interactions remain available for consultation and can accumulate over time. Data-driven policing therefore creates a form of institutional memory in which previous police activity becomes an input into subsequent decision-making (Brayne, 2020). Earlier encounters are not simply preserved; their continued availability can shape how later situations are understood. Organisational norms and shared expectations may further influence how officers interpret such records, because officers learn not only from

formal rules but also from the experiences and assessments embedded within their organisational environment (Epp et al., 2017; Mastrofski et al., 1994).

This process is closely related to the concept of secondary sanctioning. Previous police contact may acquire significance beyond the original encounter when accumulated records contribute to continued scrutiny or influence subsequent assessments (Boers et al., 2023; McGlynn-Wright et al., 2022). The concept does not imply that every previous police contact leads to further intervention. Rather, it highlights how police attention can become consequential through the information it leaves behind. This possibility is also relevant to broader concerns about data-driven policing. Schuilenburg and Giebels (2025) argue that digital traces are not necessarily socially neutral, because they may reflect existing inequalities in who comes to police attention and therefore leaves records. When some groups generate more digital traces than others, these data may contribute to disproportionate attention, erroneous inferences, and self-reinforcing patterns of police attention. The present study focuses on a potential interpretive mechanism within this broader process: whether accumulated evidence of prior police attention itself becomes a cue of relevance.

This distinction is particularly important for understanding the design of MEOS. The system presents officers with numerical indicators of previous police activity, including the number of Checks and Registrations. The intended logic is that these indicators help officers reflect on the history of police attention. A pattern of many Checks combined with few Registrations should indicate that previous interventions have produced limited enforcement outcomes and may therefore provide a reason for restraint. In this sense, the system attempts to transform accumulated police activity into a feedback signal that can counter unnecessary discretionary intervention.

Yet the same information can support a different interpretation. A high number of Checks may indicate not only that previous encounters produced few enforcement outcomes, but also that multiple officers repeatedly considered the person or vehicle worthy of attention. If officers use the frequency of prior attention as a cue about professional relevance, numerical feedback may therefore have an unintended meaning. Rather than communicating "previous attention produced little," it may communicate "previous officers repeatedly found this noteworthy."

This possibility leads to the central theoretical proposition of the present study: the informational meaning of prior police attention may depend not only on its enforcement outcomes but also on the amount of attention itself. If so, increasing the number of previous Checks should increase perceived relevance or suspicion even when the number of Registrations remains low. Conversely, enforcement Registrations may provide a separate signal of relevance because they indicate that previous encounters resulted in formal police action. Examining Checks and Registrations separately therefore makes it possible to distinguish between the effect of accumulated attention and the effect of accumulated enforcement outcomes.

Study 1: Exploratory pilot

We first conducted an exploratory pilot to examine how police officers interpreted numerical information about prior police activity presented through MEOS. The pilot was intended to inform the design of a more controlled test in Study 2.

Forty-seven Dutch police officers and Police Academy students participated. The pilot included an immersive VR component and an exploratory survey component. In the VR component, participants encountered a group of young people near a vehicle in a patrol

setting and were asked whether they would approach the individuals. The intended manipulation of access to MEOS information was not implemented consistently during data collection. We therefore do not use this component as evidence concerning the effect of MEOS information on simulated intervention decisions.

In the survey component, participants evaluated a standardised scenario involving an expensive middle-class vehicle and three MEOS configurations representing low, intermediate, and high levels of prior police activity. Figure 2 shows that the configurations contained, respectively, 1 licence-plate query, 2 stop-checks, and 0 registrations (low); 21 queries, 13 stop-checks, and 2 registrations (intermediate); and 126 queries, 78 stop-checks, and 62 registrations (high). The configurations were followed by six exploratory measures assessing interpretations of the MEOS information, including perceived noteworthiness, suspicion, evaluative judgments, and anticipated use of the information in discretionary decision-making.

A multivariate analysis of variance indicated a significant overall effect of MEOS information across the six interpretation measures, $F(12, 27) = 19.59$, $p < .001$, Wilks' $\Lambda = .10$. Follow-up analyses indicated significant effects on all six measures (all $p < .001$). Higher counter values were generally associated with stronger perceptions that the vehicle or its owner was noteworthy, suspicious, and relevant to discretionary action. For example, perceived noteworthiness increased from $M = 2.18$ ($SE = .17$) in the low condition to $M = 4.72$ ($SE = .08$) in the high condition. Endorsement of a "where there's smoke, there's fire" interpretation increased from $M = 1.67$ ($SE = .12$) to $M = 3.18$ ($SE = .19$), while anticipated use of the information increased from $M = 2.26$ ($SE = .15$) to $M = 4.15$ ($SE = .14$). Descriptive statistics and Bonferroni-adjusted pairwise comparisons are reported in Supplementary Tables S1 and S2.

The pilot had several limitations. The survey configurations were presented in a fixed order, the interpretation measures were developed specifically for this study, and the design did not allow the effects of Checks and Registrations to be disentangled. The findings should therefore be regarded as exploratory rather than confirmatory. Nevertheless, the consistent pattern suggested that higher levels of prior police activity could be associated with stronger perceptions of relevance and suspicion. This finding motivated Study 2, in which access to MEOS information was experimentally manipulated in a controlled VR task and Checks and Registrations were independently varied in a randomised within-participants design.

Study 2: Replication and Extension

In the follow-up study, we aimed to replicate and extend the exploratory findings of Study 1. Several methodological improvements were introduced. First, the MEOS manipulation in the behavioural VR component was implemented as intended: participants in the experimental condition had access to MEOS information (the counters they got to see were respectively, 1 licence-plate query, 2 stop-checks, and 0 registrations; see Figure 1), whereas participants in the control condition did not. Second, the interpretation component was redesigned to distinguish between prior police attention and enforcement outcomes. Specifically, the number of previous Checks and the number of Registrations were systematically varied within participants, allowing us to examine how officers interpreted repeated attention depending on whether it was accompanied by enforcement outcomes. Each participant evaluated all four combinations of Checks and Registrations, and the four configurations were presented in randomised order.

Method

Participants

A total of 114 Dutch police officers participated in the between-participants experiment. Of these participants, 27 were female, 79 were male, and 8 did not disclose their gender. Participants ranged in age from 21 to 65 years (M = 39.02, SD = 12.43) and had an average of 14.45 years of police experience (SD = 12.36).

After completing the between-participants experiment, participants were invited to take part in the within-participants experiment. Seventy officers completed this second part. This subsample consisted of 16 female and 54 male officers, with a mean age of 42.49 years (SD = 12.21) and an average of 18.34 years of police experience (SD = 11.69).

Attrition between the two experiments was primarily due to practical constraints during data collection. Many participants were scheduled to attend mandatory firearms training immediately after the first experiment and therefore had limited time available to complete the second experiment.

Design

The study consisted of two complementary components. The first component used a between-participants experimental design. Participants were randomly assigned to either a condition in which MEOS information was available or a control condition in which MEOS information was unavailable. The outcome measure was whether participants decided to approach the individuals near the vehicle in the simulated scenario.

The second component used a 2 × 2 within-participants factorial design. Each participant evaluated four MEOS configurations referring to the same licence plate number. The two factors were prior police attention (Checks: few vs. many) and enforcement outcomes (Registrations: few vs. many). This design allowed us to examine the independent effects of

Checks and Registrations, as well as their interaction, while each participant served as their own control. The four configurations were presented in randomised order to reduce potential order and carryover effects.

Checks were operationalised as either few (2 prior licence-plate queries and 1 stop-check) or many (28 prior licence-plate queries and 20 stop-checks). Registrations were operationalised as either few (0 BVH registrations) or many (19 BVH registrations). The four resulting MEOS configurations were presented in randomised order (Figure 3).

[Figure 3 near here]

Procedure

Participants were recruited during field visits to three police training facilities. Entire classes of police officers were approached by their instructors and invited to participate. Participation was voluntary and based on informed consent. No financial incentives were provided, although participants were offered coffee and cake.

The procedure consisted of two consecutive experiments. First, participants completed an immersive VR experiment. The VR scenario followed the general structure of Study 1: participants encountered a group of individuals near a vehicle in a patrol setting and were asked whether they would approach the individuals. Depending on the experimental condition, MEOS information was either available or unavailable during the scenario.

After completing the VR experiment, participants were presented with four MEOS screens referring to a fixed licence plate number. Each screen displayed a different combination of prior Checks and Registrations. The order of presentation was randomised to reduce possible order effects. After each MEOS screen, participants completed five interpretation measures.

Measures

The within-participants experiment included five measures assessing officers' interpretations of MEOS information:

1. perceived attention by colleagues ("This MEOS information indicates that colleagues found (the registered owner of) this vehicle notable");
2. perceived confirmation of suspicion ("This MEOS information confirms my suspicion that there may be something wrong with (the registered owner of) this vehicle");
3. heuristic suspicion ("This MEOS information makes me think 'where there's smoke, there's fire'");
4. overall evaluation of the vehicle owner ("What picture does this MEOS information give of (the registered owner of) this vehicle?"); and
5. stated willingness to use the information when deciding whether to take action ("Would you use this information in your decision to take action in this situation?").

Responses were measured on five-point scales, with higher scores indicating stronger agreement, more negative evaluations, or greater willingness to use the information. As in Study 1, these measures were developed specifically for this research and should be interpreted as indicators of officers' interpretations of MEOS information rather than as validated psychological scales.

Results

VR Outcome: Simulated Intervention Decisions

To examine whether access to MEOS information influenced simulated intervention decisions, intervention rates were compared between the control and experimental groups.

Of the 114 participants, 53 were assigned to the control condition and 61 to the MEOS condition. A chi-square test of independence showed no statistically significant association between MEOS access and the decision to approach the individuals in the VR scenario, $\chi^2(1, N = 114) = 0.02$, $p = .57$. Exposure to MEOS counters, therefore, did not produce a detectable effect on simulated intervention decisions.

Within-Participants Outcome: Interpretation of MEOS Information

To examine how officers interpreted different MEOS configurations, a repeated-measures ANOVA was conducted with Checks and Registrations as within-participant factors and the five interpretation measures as dependent variables.

The analysis showed significant multivariate main effects of Checks, $F(5, 65) = 12.42$, $p < .001$, Wilks' $\Lambda = .51$, and Registrations, $F(5, 65) = 22.60$, $p < .001$, Wilks' $\Lambda = .37$. In addition, the interaction between Checks and Registrations was significant, $F(5, 65) = 6.03$, $p < .001$, Wilks' $\Lambda = .68$.

Follow-up univariate analyses were conducted for each interpretation measure separately.

Across all measures, higher levels of MEOS information were associated with stronger perceptions that the vehicle or owner was noteworthy, more negative evaluations, greater suspicion, and greater stated willingness to use the information in decision-making.

[Table 1 near here]

As can be seen in Table 1, both higher Checks and higher Registrations increased ratings of perceived conspicuousness. Officers perceived the vehicle or owner as more noteworthy when the MEOS information showed greater previous attention. A significant interaction indicated that the effect of Checks differed depending on the number of Registrations.

[Table 2 near here]

For the suspicion measure ("where there's smoke, there's fire"), both Checks and Registrations showed significant effects; see Table 2. Higher levels of both forms of information were associated with stronger agreement that the information confirmed possible wrongdoing.

[Table 3 near here]

For overall evaluation of the vehicle owner, both higher Checks and higher Registrations resulted in more negative evaluations. The findings indicate that accumulated numerical indicators of prior police activity influenced impressions of the person associated with the vehicle. See Table 3.

[Table 4 near here]

For willingness to use the information when deciding whether to act, both Checks and Registrations showed significant effects; see Table 4. Higher levels of prior attention and enforcement outcomes were associated with a greater reported likelihood of incorporating the information into decision-making.

[Table 5 near here]

Finally, perceived likelihood that something was wrong with the vehicle owner was also influenced by both Checks and Registrations. Higher values on both dimensions increased suspicion. See Table 5.

Overall, the within-participants results showed a consistent pattern: numerical indicators of previous police attention influenced officers' interpretations of the information. Rather than

functioning primarily as a restraining signal, higher numbers of prior checks and registrations were associated with increased perceived relevance, suspicion, and stated willingness to act.

Preliminary Conclusion

Study 2 replicated the interpretive pattern identified in Study 1 under stronger experimental conditions. The controlled VR component did not show evidence that MEOS information affected simulated intervention decisions. However, the survey component demonstrated consistent effects of MEOS counters on officers' interpretations of numerical feedback.

Specifically, repeated indicators of prior police attention were associated with stronger perceptions of relevance, suspicion, and willingness to incorporate the information into decision-making. These findings suggest that numerical feedback about previous police activity may influence how officers interpret situations, even when such information does not translate directly into measurable behavioural changes within a simulated environment.

Rather than demonstrating that MEOS counters increase police interventions, the findings indicate that the meaning assigned to accumulated digital traces may differ from the intended design logic of the system. Study 2 therefore provides evidence that numerical indicators of prior attention can function as interpretive cues within discretionary policing contexts.

Conclusion and Discussion

Digital decision-support systems are often introduced with the expectation that (more) information will improve decision-making. This study demonstrates that information systems do not operate independently of the contexts in which they are used. Numerical indicators of previous police attention can acquire meanings beyond their intended purpose.

Across two studies, MEOS counters influenced officers' interpretations of vehicles and individuals, even though they did not produce measurable changes in simulated intervention

decisions. These findings suggest that repeated administrative traces may function as signals of relevance within discretionary policing contexts.

Importantly, these findings should be distinguished from evidence of behavioural change. The effects observed in the within-participants experiment concern officers' perceptions and stated willingness to use the information, whereas the VR experiment showed no detectable effect on simulated intervention decisions. Neither study therefore provides evidence that MEOS counters increase police interventions in operational practice.

Numerical Feedback in Discretionary Policing

This study examined how police officers interpret numerical feedback about previous police activity embedded in the MEOS application. The system was designed to support more proportionate discretionary decision-making by signalling when repeated checks had produced limited enforcement outcomes. Across two studies, however, we found a consistent divergence between the intended logic of the system and how officers interpreted the information presented to them.

In both studies, access to MEOS information did not produce a detectable effect on simulated intervention decisions in the VR scenarios. Nevertheless, the more fine-grained follow-ups, notably the within-participants experiment in Study 2, showed consistent effects of MEOS counters on officers' interpretations. Higher numbers of prior checks and registrations were associated with greater perceived relevance, stronger suspicion, more negative evaluations of the vehicle owner, and a higher stated willingness to use the information when deciding whether to act.

These findings suggest that high numerical indicators of prior police attention may function as interpretive cues. Rather than automatically being understood as evidence that previous

checks had generated limited enforcement value, repeated attention appeared to acquire meaning in itself. In other words, the informational value of the counters may not lie only in what the numbers objectively represent, but also in what they communicate about previous professional attention.

This pattern is consistent with research showing that decision-making under uncertainty relies partly on salient and easily interpretable cues (Kahneman, 2011; Tversky & Kahneman, 1974). In policing contexts, where officers have to make rapid assessments based on incomplete information, repeated indicators of prior attention may become meaningful signals. A high number of previous checks may therefore be interpreted not only as an absence of enforcement outcomes but also as an indication that a person or vehicle has repeatedly attracted professional interest.

From Digital Records to Institutional Meaning

The findings suggest that the effects of digital policing systems depend not only on the information they contain, but also on the meaning users assign to that information. In MEOS, counts of previous checks and registrations are presented as descriptive indicators of prior police activity. Yet officers may interpret these counts as signals about the relevance of the person or vehicle to other officers. The numbers therefore communicate two forms of information simultaneously: what happened previously and, potentially, how much professional attention the person or vehicle has attracted.

This distinction helps connect the present findings to research on secondary sanctioning. Previous police contact can acquire significance beyond the event that generated it when accumulated records contribute to subsequent assessments (Boers et al., 2023; McGlynn-Wright et al., 2022). Although our findings do not demonstrate secondary sanctioning in the stronger sense of repeated police intervention, they instead identify a potential interpretive

mechanism through which it may develop: prior police attention can itself become a cue of relevance.

This mechanism also highlights why digitalisation does not necessarily make discretionary policing more neutral. When historical police activity is transformed into persistent and readily accessible information, earlier patterns of attention become available to inform later judgements. The resulting feedback loop may be particularly consequential when the original distribution of police attention was already uneven. Digital systems can therefore preserve and amplify the informational consequences of earlier encounters even when their designers intend the information to encourage restraint.

Implications for Ethnic Profiling and Unequal Policing

The findings raise questions about how digital traces may interact with existing inequalities in police contact. Research has documented that some minority groups experience disproportionate levels of police attention (FRA, 2017, 2019; Pierson et al., 2020). When repeated encounters generate administrative records, those records may subsequently become available as information that influences future interpretations. In such circumstances, earlier differences in police attention could potentially become embedded in future decision-making processes.

The implication is therefore not that digital systems necessarily create ethnic disparities, but that systems relying on accumulated police data may reproduce existing patterns if the meaning of those data is not carefully considered. Understanding how officers interpret digital records is therefore important for designing interventions intended to reduce disproportionate police stops.

Implications for the Design of Digital Decision-Support Systems

The findings highlight a broader challenge for digital decision-support systems in policing. Providing information does not guarantee that users will interpret that information according to the intentions of system designers. Numerical feedback must be understood within the practical realities of police work, including professional expectations, organisational cultures, and existing decision-making routines.

For MEOS specifically, the results suggest that simply presenting counts of previous checks and registrations may be insufficient to achieve the intended behavioural effect. If repeated attention itself becomes interpreted as meaningful, numerical feedback may reinforce existing patterns of interpretation rather than encourage reflection. Future system design should therefore consider not only what information is presented, but also how that information is framed and explained to users.

An important question for future research is whether officers are aware of the intended function of such feedback and how its meaning is communicated within the organisation. If users are not explicitly informed that high numbers of Checks with few Registrations are intended to encourage restraint, their interpretation of the counters may reflect not only the design of the technology but also existing professional norms and organisational expectations regarding proactive policing. Future research should therefore examine how MEOS is introduced, explained, and embedded in organisational practice.

More advanced technologies, including AI-supported decision systems, do not automatically resolve these challenges. Complex systems remain dependent on the quality of available data, the way information is selected and presented, and how users interpret resulting outputs. If historical records reflect selective attention or existing inequalities, more advanced systems may reproduce rather than eliminate these patterns. Future research should therefore examine

not only technical performance, but also how decision-support tools are integrated into professional practice.

Limitations

Several limitations should be considered when interpreting these findings.

First, both studies relied in part on simulated VR scenarios rather than observations of operational police behaviour. Although VR allows experimental control, decisions in real-world encounters involve additional information, interactions, and organisational pressures that cannot be fully captured in a laboratory setting (Fox et al., 2009). The VR scenario also contained several contextual cues that could attract police attention, including the presence of young people, a luxury vehicle, and a degraded environment. These features may have increased the baseline likelihood of intervention and thereby limited the extent to which the MEOS manipulation could further affect the binary behavioural outcome. At the same time, participants were not required to intervene: as part of the briefing, they were explicitly informed that they could choose not to approach, continue observing the situation, or wait until the simulation ended automatically after two minutes. Thus, participants had a meaningful opportunity to refrain from intervention. The absence of a detectable behavioural effect should therefore not be interpreted as evidence that participants had no meaningful choice, but the relatively strong situational cues may nevertheless have constrained the range of possible responses. This may help explain why MEOS information affected officers' interpretations in the within-participants component but did not produce a detectable difference in simulated intervention decisions.

Second, the survey measures were developed specifically for this research context because no established scales exist for assessing interpretations of MEOS information. The findings

should therefore be viewed as evidence of a pattern in officers' responses rather than as a complete measurement of the underlying psychological or organisational processes involved.

Future research should examine how officers interpret digital information systems during actual operational decision-making. In particular, research should investigate how numerical indicators interact with professional experience, organisational expectations, and existing patterns of police contact. Such work can help clarify when digital feedback supports reflective decision-making and when it risks reinforcing existing assumptions.

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Tables and Figures

Figure 1. MEOS interface shown in VR from the officer's point of view, including real-time counter information.

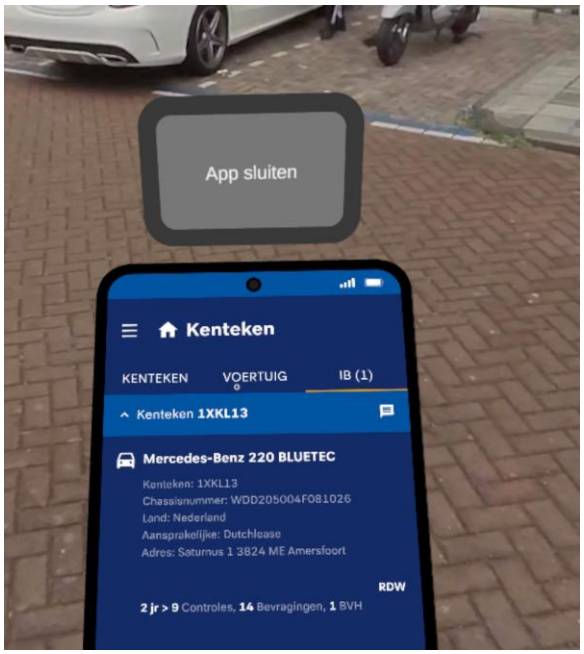


Figure 2. The three consecutive MEOS screens used in the pilot study; low (left), intermediate (center), and high (right) numbers of licence plate checks, stop-checks, and registrations ("controles", "bevragingen", and "BVH", respectively).

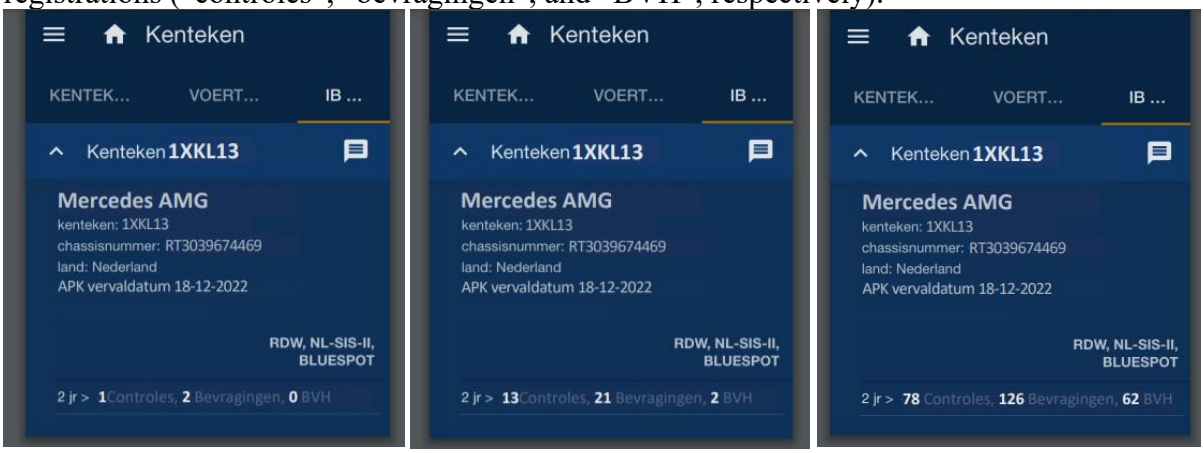
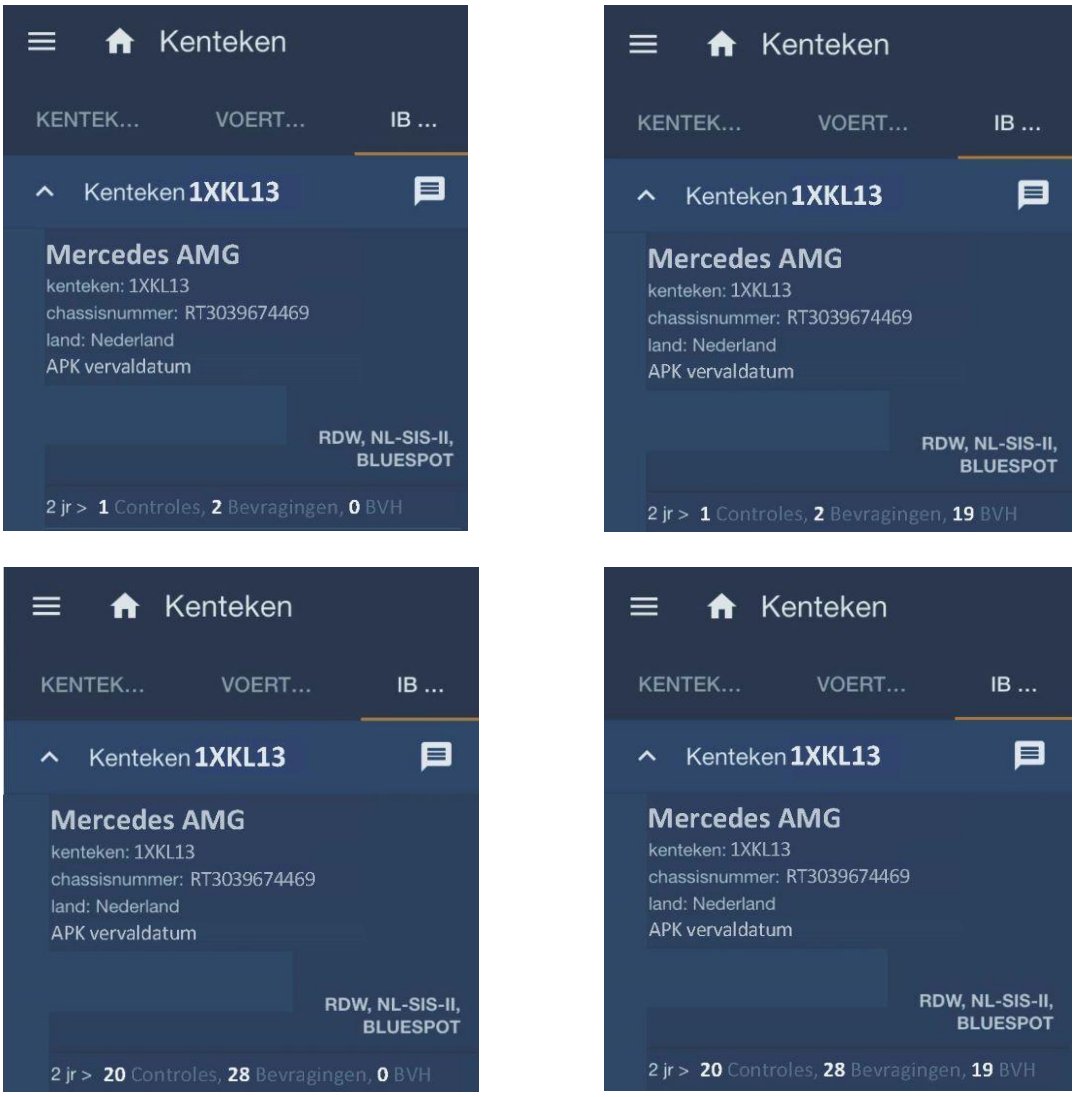


Figure 3. The four MEOS screens used in Study 2; few checks & few registrations (top left), few checks & many registrations (top right), many checks & few registrations (bottom left), and many checks & many registrations (bottom right).



Supplementary Table S1. Means and standard errors of the six measures for each MEOS screen

	MEOS Information					
	Low		Intermediate		High	
Measures	*M*	*SE*	*M*	*SE*	*M*	*SE*
1	2.18	.17	3.92	.15	4.72	.08
2	2.13	.15	3.23	.16	2.23	.21
3	1.67	.12	2.39	.15	3.18	.19
4	3.31	.11	2.36	.09	1.87	.12
5	2.87	.15	3.23	.17	3.85	.17
6	2.26	.15	3.28	.17	4.15	.14

Supplementary Table S2. Contrasts between the three levels of MEOS Information for all six measures

	MEOS Information Contrasts		$M_{Difference}$		
Measures	a	b	(a-b)	*SE*	*p*
1	Low	Intermediate	-1.74	.24	< .001
		High	-2.54	.19	< .001
	Intermediate	High	-0.80	.14	< .001
2	Low	Intermediate	-1.10	.21	< .001

Table 1 Mean ratings of perceived conspicuousness as a function of Checks and Registrations; higher scores indicate stronger perceptions that the vehicle or owner was noteworthy

		Registrations					
		Few		Many		Total	
		M	SE	M	SE	M	SE
Checks	Few	2.61	.15	3.89	.12	3.25	.10
	Many	4.16	.14	4.43	.10	4.29	.10
	Total	3.39	.10	4.16	.10		

		High	-0.10	.26	1.000
	Intermediate	High	1.00	.28	.003
3	Low	Intermediate	-0.72	.19	.002
		High	-1.51	.21	< .001
	Intermediate	High	-0.80	.18	< .001
4	Low	Intermediate	0.95	.15	< .001
		High	1.44	.15	< .001
	Intermediate	High	0.49	.13	.001
5	Low	Intermediate	-0.36	.17	.112
		High	-0.97	.17	< .001
	Intermediate	High	-0.62	.15	< .001
6	Low	Intermediate	-1.03	.19	< .001
		High	-1.90	.18	< .001
	Intermediate	High	-0.87	.17	< .001

Note: p-values are Bonferroni adjusted for multiple testing.

Table 2 Mean ratings of heuristic suspicion ("where there's smoke, there's fire") as a function of Checks and Registrations; higher scores indicate stronger agreement

		Registrations					
		Few		Many		Total	
		M	SE	M	SE	M	SE
Checks	Few	2.11	.14	3.24	.13	2.68	.10
	Many	2.80	.15	3.76	.12	3.28	.12
	Total	2.46	.11	3.50	.11		

Table 3 Mean ratings of overall evaluation of the vehicle owner as a function of Checks and Registrations; higher scores indicate a more negative evaluation

		Registrations					
		Few		Many		Total	
		M	SE	M	SE	M	SE
Checks	Few	2.97	.08	2.40	.07	2.69	.06
	Many	2.66	.11	1.93	.09	2.29	.07
	Total	2.81	.07	2.16	.07		

Table 4 Mean ratings of willingness to use MEOS information when deciding whether to take action as a function of Checks and Registrations; higher scores indicate greater willingness

		Registrations					
		Few		Many		Total	
		M	SE	M	SE	M	SE
Checks	Few	2.91	.12	3.63	.11	3.27	.10
	Many	3.30	.14	4.01	.10	3.66	.10
	Total	3.11	.10	3.82	.10		

Table 5 Mean ratings of perceived likelihood that something is wrong with the vehicle owner as a function of Checks and Registrations; higher scores indicate greater perceived likelihood

		Registrations					
		Few		Many		Total	
		M	*SE*	*M*	*SE*	*M*	*SE*
Checks	Few	2.59	.13	3.71	.10	3.15	.10
	Many	3.14	.14	4.06	.11	3.60	.10
	Total	2.86	.11	3.89	.09		