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Research Article

Algorithmization of Bureaucratic Organizations: Using a Practice Lens to Study How Context Shapes Predictive Policing Systems

Abstract: *The current scientific debate on algorithms in the public sector is dominated by a focus on technology rather than organizational patterns. This paper extends our understanding of these patterns by studying the algorithmization of bureaucratic organizations, which is the process in which an organization rearranges its working routines around the use of algorithms. To explore the algorithmization of bureaucratic organizations, we conducted a comparative empirical analysis of predictive policing in Berlin (Germany) and Amsterdam (Netherlands) through in-depth qualitative research. Our study identified two emergent patterns: the 'algorithmic cage' (Berlin, more hierarchical control) and the 'algorithmic colleague' (Amsterdam, room for professional judgment). These patterns result from administrative cultures and reinforce existing patterns of organization. The study highlights that two patterns of algorithmization of government bureaucracy can be identified and that these patterns depend on dominant social norms and interpretations rather than the technological features of algorithmic systems.*

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Evidence for practice

- The organizational rearrangement around the use of algorithms consists of six components: technology, expertise, information relations, organizational structure and policy, as well as monitoring and evaluation;
- The outcome of the process of organizational rearrangement around the use of an algorithm is not determined by the technological features but influenced by social norms and interpretations of the facilities of algorithmic systems;
- At least two different outcomes of the algorithmization of bureaucratic organization can be identified: the 'algorithmic cage' (hierarchical control) and the 'algorithmic colleague' (room for professional judgment);
- An assessment of predictive policing requires an in-depth understanding of how the algorithm is used in the organization since we cannot assume that the organization blindly follows the system's recommendations.

The promise of algorithms is a more effective public sector based on innovative analyses of information. This promise has been echoed in sectors as diverse as transportation, criminal justice, policing, education, and healthcare, and Danaher et al. (2017, p. 1) even refer to the present time as "an algorithmic age". These terms mirror a widespread belief that the introduction of these new technologies in the public sector will result in radical changes. As recent work in sector as diverse as social security (Eubanks 2018), education (O'Neil 2016), child welfare (Redden, Dencik, and Warne 2020), and policing (Brayne 2021) shows, these changes can contribute to effectiveness but also produce risks such as bias, discrimination, and lack of democratic control (Veale, van Kleek, and Binns 2018). For these reasons, the algorithmization of the public sector demands the attention of scholars in the field of public administration (Andrews 2019; Busuioc 2020; Vogl et al. 2020).

Algorithms are admired and mystified but from a more sober perspective, they are basically encoded procedures for performing a task (Cormen 2013; Gillespie 2014). What makes new technologies so intriguing is that they have the ability to rearrange social practices (Barley 1990; Orlikowski and Scott 2008). Therefore, we need a broader understanding "that includes not just algorithms, but also the computational networks in which they function, the people who design and operate them, the data (and users) on which they act, and the institutions that provide these services, all connected to a broader social endeavor and constituting part of a family of authoritative systems for knowledge production" (Yeung 2018, p. 506). Thus, the use of algorithms is a socio-technical phenomenon that must be seen in context to understand its complexity and consequences.

At the moment, the scientific debate on algorithms in the public sector is dominated by a focus on the

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algorithm rather than the organizational patterns around its use (Fink 2018; Janssen and Kuk 2016). Particular attention is given to revealing potential or actual flaws of algorithmic technologies and how they can reinforce existing biases (Katzenbach and Ulbricht 2019; Tutt 2017). Even though these analyses are highly relevant, we argue that an understanding of the relation between algorithm and organizational context is needed to comprehend how the algorithm is actually used and why algorithms have certain effects in specific contexts. There is a need to understand the relation between the use of algorithms and the basic structure of government organizations: the bureaucracy (Wilson 1989). For this reason, we formulated the following research question: how do bureaucratic organizations rearrange their working routines around the use of algorithms?

To develop an understanding of algorithmization as a socially embedded process in government bureaucracies, we have conducted an in-depth empirical analysis of predictive policing in Amsterdam (Netherlands) and Berlin (Germany). These contexts are similar in many ways but also reflect different administrative cultures, with more professional autonomy in the Netherlands and a stricter focus on bureaucracy in Germany (Soeters, Hofstede, and van Twuyver 1995). Predictive policing promises to boost the effectiveness and legitimacy of the police through the ostensible control of crime (Bennett Moses and Chan 2016; Meijer and Wessels 2019). The combination of advanced algorithms, highly formalized organizations, and a pressure to enhance effectiveness and legitimacy of policing makes this practice a highly informative case for understanding the algorithmization of bureaucratic organizations.

Theoretical Framework: Algorithmization in the Public Sector

Algorithms

The advent of algorithms in the public sector receives more and more scholarly attention (Veale and Brass 2019; Yeung 2018). This seems plausible considering that algorithms differ in important ways from information and communication technologies (ICT) that have been introduced to organizations throughout the second half of the twentieth century. The unprecedented availability of data and the increase of computing capacity have given rise to relatively new techniques, such as machine learning, that enable pattern recognition and prediction.

In general, algorithms are encoded procedures for performing a task by turning input data into output based on specified calculations (Cormen 2013). More practically, one could say that an algorithm converts data into information to make decisions and to guide practices (Alavi and Leidner 2001). Compared to other information technologies, the automation of data processing is much more advanced due to the machine learning capabilities. Machine learning means that algorithms are enabled to automatically analyze input data, to detect patterns and structures, and based on that to create models with optimized outputs (Kitchin 2014).

A key distinction can be made between an algorithmic system that acts on its own or one that provides an advice to a human decision-maker. These systems are usually referred to as automation systems and decision-support systems, respectively (Veale and Brass 2019) and they can be applied in organizational contexts with different intentions and actual effects. "While earlier approaches conceived of algorithms as either augmenting or reducing human agency, it has become clear that the interaction between human and machine agents is complex and needs more differentiation" (Katzenbach and Ulbricht 2019, p. 6). Young, Bullock, and Lecy (2019) refer to this distinction as the level of 'algorithmic discretion' and indicate that this discretion is high for automation systems and low for decision-support systems.

Socio-Technical Perspective on Algorithms

When used in organizations, algorithms can rearrange the processes in which they are embedded. The understanding of how these organizational rearrangements play out in practice is, however, still very limited besides a few well-researched cases (see e.g. Christin 2017). Even though advanced machine learning algorithms are new, an academic analysis of their impact on organizations can build upon already tried-and-tested ways of studying the role of technology in organizational rearrangements (Barley 1990; Orlikowski 1992; Orlikowski and Scott 2008; Zammuto et al. 2007). In particular, studies on the use of ICT in the public sector seem to be an important strand of the literature on which contemporary research into the use of algorithms should build (Fountain 2004; West 2005; Dunleavy et al. 2006; Gil-Garcia 2012).

In the 1990s, with the increasing prevalence of personal computers in the public sector, scholars in public administration started studying the organizational rearrangements around the use of this technology. This process, denoted as informatization, includes organizational structures and policies, information streams and relations, as well as expertise; all in relation to ICT (Snellen and Van De Donk 1998; Zuurmond 1994). Thus, instead of centering on the technology, informatization research emphasizes the social processes in which the use of technology is negotiated. Rethinking Weber's ideal-typical bureaucracy, Zuurmond (1994) conceptualized a new type of public organization shaped by informatization—the 'infocracy'—with increased social control and authority attributed to the use of ICT (see also: Fountain 2004; Gil-Garcia 2012; Snellen 2012). Another seminal contribution to the understanding of the rearrangement of government bureaucracy around ICTs was made by Bovens and Zouridis (2002) who showed that ICT restructured public organizations via an intermediate state ('screen-level bureaucracy') into a new type of organization ('system-level bureaucracy'). The 'system-level bureaucracy' reinforces pressures toward higher standardization, formalization, and centralization (Bovens and Zouridis 2002; for recent overviews of the literature on system-level bureaucracies: Buffat 2015; Busch and Henriksen 2018).

Drawing on the insights gained from informatization research, the process of organizational rearrangement around algorithms is called algorithmization. We define algorithmization as "a process in which an organization rearranges its working routines around the use of algorithms for its actions and decisions". This definition stresses the focus on 'working routines' rather than putting the technological artifact center stage and highlights the implications for 'organizational actions and decisions'. Based on Zuurmond's (1994) conceptualization of informatization, a distinction can be made between six components of algorithmization: technology, expertise,

information relations, organizational structure and policy, as well as monitoring and evaluation. These key components are summarized in Table 1.

Algorithms-in-Practice as an Empirical Lens

Building upon the extensive literature on technology in organization (Barley 1990; DeSanctis and Poole 1994; Yates, Orlikowski, and Okamura 1999), Orlikowski's (2000) technologies-in-practice theory ties in well with our perspective on algorithmization as a social process since her theory is based on the assumption of interdependence between technology and human behavior. From this perspective, technology cannot force certain ways of usage; it "can only condition social practices" (Orlikowski 1992, p. 411) and attention must be paid "to what people do with technology in their everyday practices and how such use is structured by rules and resources" (Orlikowski 2000, p. 421). Rules and resources, in turn, arise out of the broader context of social structures. This technologies-in-practice lens forms the basis for our study of algorithms in bureaucratic organization (for another application of this perspective to the study of algorithms in the public sector: Christin (2017)).

To analyze these and other practices around algorithms in public organizations, three elements of Orlikowski's technologies-in-practice lens are used after slight adjustments. First, technology provides different options of usage, called facilities by Orlikowski (2000). The facilities indicate how the system *can* be used. The facilities do not only include the technology as such but also the other elements of the process of algorithmization (i.e. expertise, information relations, organizational structure, and policy, as well as monitoring and evaluation). Facilities of algorithms include the visualization of processes, the analysis of developments of time, the presence or absence of customization options as well as of disclosures of the underlying data, code, and organizational procedures.

Second, the norms and values that stem from organizational context, as well as from the professional background of the user, prescribe how technology *should* be used. For algorithmization, this means that differences in the organizational use of algorithms result from differences in norms and values that shape this usage. For example, the use of algorithms might differ between a more hierarchical organization with an obligatory use of the algorithm and a less hierarchical organization that stipulates voluntary use.

Third, in the understanding of Orlikowski (2000), the knowledge and assumptions individuals have regarding the technology in question are seen as their interpretative schemes and they indicate what the system *means* to the users. The particular attributes of an interpretative scheme shape how the individual makes use of the technology. For example, having little knowledge but holding many negative assumptions regarding algorithms might induce the user to dismiss algorithms and deny their value (e.g. foot-dragging). Another particular interpretative scheme might give a user a lot of trust in the algorithm, which leads to a practice that affirms the value of algorithms.

Orlikowski's (2000) perspective on studying technology in practice enables us to analyze how the use of algorithms interacts with the structure of bureaucratic organization. Bureaucracy presents a set of norms—neutrality, legality, predictability, and accountability—and also a range of interpretative schemes—hierarchy, standards, procedures, and reports—that guide the behavior of individuals (Wilson 1989). An empirical analysis of the interaction between these norms and interpretative schemes and the facilities of algorithms can provide insight in the relation between algorithms and bureaucracy. We used this perspective as a lens to study a specific use of algorithms in a bureaucratic organization: predictive policing.

Table 1 Core Features of Algorithmization

Technology	The process of algorithmization starts with the introduction of a technology into organizational processes. The algorithm can be a standalone decision-support system but also a system that is well integrated in the organization's infrastructure.
Expertise	The use of algorithms in an organization requires a variety of expertise. Experts are needed who know how to work with the system but also experts who maintain the algorithm and ensure that it is properly installed into the organization's information environment.
Information relations	The algorithm builds upon both existing information in the organization and new information. This means that the algorithm has an effect on the information relation within the organization and also outside of it when information from other actors is used.
Organizational structure	The use of the algorithm requires new collaborations between different departments. The algorithm can also result in new forms of organizational control when implementation of processes is dictated by the algorithm.
Organizational policy	Organizations develop policies for the use of the algorithm. These policies touch upon issues such as the transparency of the algorithm, responsibilities for usage, maintenance, etc.
Monitoring and evaluation	Organizations develop methods and systems for monitoring and evaluating the foreseen and unforeseen outcomes of the use of algorithms in terms of output and effects.

Predictive Policing

Throughout the twentieth century, the emphasis on crime control and the promise of public order through rational action has been at the heart of police legitimacy (Monkkonen 1981; Walker 1984). Nowadays, police forces are increasingly adopting algorithms for 'predictive policing', in which algorithms are administered to make on the basis of historical and criminal data estimations of where -or by whom- criminal offenses might occur. Thus, predictive policing has the presumption that crime can be preempted by making statistical inferences from historical (big) data. On the basis of a systematic literature review, Meijer and Wessels (2019, p. 1033) provide the following definition: "[p]redictive policing is the collection and analysis of data about previous crimes for identification and statistical prediction of individuals or geospatial areas with an increased probability of criminal activity to help developing policing intervention and prevention strategies and tactic."

There is a widespread debate among scholars and practitioners what the benefits and drawbacks of this policing approach are (Bennett Moses and Chan 2016; Lum and Isaac 2016). First, there are disagreements whether this approach indeed increases the efficiency and effectiveness of law enforcement agencies. Second, it is argued that predictive policing poses risks of predictive policing models that are opaque in how output is derived, have discriminatory effects, or that there are ethical and privacy issues to administering big data. The debate about predictive policing has become quite intense and

has generated media attention in various countries. The polarized debate, however, is not conducted on the basis of sound empirical evidence. Meijer and Wessels (2019) conclude that both these benefits and drawbacks are lacking unambiguous empirical evidence and emphasize the need to study how predictive models are used in practice.

Research Design

The aim of this study is to understand the interaction between algorithms and the bureaucratic organization of the police. Two police organizations in different countries—the Netherlands and Germany—are selected for a comparative case study. To study the use of predictive policing models in practice, this research takes an in-depth qualitative approach similar to Beer (2016) and Christin (2017). The logic of case selection was done on the basis of two axes: comparability of the technology and differences in the organizational context in which the technology is implemented.

The first axis is the comparability of the technology. For this comparative study, the Amsterdam and Berlin police forces are selected as cases as the implemented algorithms are relatively similar. Both systems are developed by the police organization itself and are based on a spatiotemporal model. Although there are some technical differences between both systems (e.g. the data-sets used), they are relatively similar and therefore suitable for this comparative case study.

The second axis for the case selection is the organizational context in which the technology is implemented. Even though systematic comparative research into administrative differences is rare, we have reason to assume that the cases reflect different administrative cultures with more professional autonomy in the Netherlands and a stricter focus on bureaucracy, standardization, and hierarchical relations in Germany (Soeters, Hofstede, and van Twuyver 1995). There is also a difference in the institutional position—the Amsterdam Police is a regional unit within the Dutch National Police, whereas the Berlin Police is independent—but, for the process of algorithmization, we assume the administrative culture to be more relevant since the Amsterdam Police operated quite independently in this process.

The qualitative empirical research of the two cases was based on the logic of the practice lens (Orlikowski 2000). We used the perspective of algorithmization to study not only the technology itself but also the organizational patterns around its usage (expertise, information relations, organizational structure, organizational policy, and monitoring and evaluation). The steps that we used in the analysis were based on Orlikowski (2000): facilities, norms and values, and interpretative schemes.

Extensive interviews with respondents at different levels of the organization combined with an analysis of key documents such as policy documents regarding the strategy of the Dutch National Police after the national reorganization formed the basis for the empirical analysis. The empirical research in Amsterdam was conducted in 2018. Within the Amsterdam police, 14 intelligence specialists were interviewed. We focused on these specialists because they work most intensively with CAS, and the implication of this choice is that the perspectives of police officers who were more indirectly affected by the system are not included in the empirical analysis. These intelligence specialists have the task to interpret the outcome of CAS, and use it together with other policing systems to develop advice for street-level officers. In Berlin, the research was conducted in 2019. Initial interviews with the initiators and developers of the model were used to be referred to more respondents that use the predictive policing model further down the line. This sampling resulted in interviews with 12 employees from different levels of the police organization. These include police leadership, operational level, and also intelligence specialists. Also in the Berlin police, they are tasked with processing the outcome of the predictive policing system and enriching it with additional information.

In both cases, we coded all the material from the studies by making use of the software Nvivo. The codes were based on the conceptual lenses: facilities, norms, and interpretative schemes. For example, as the algorithm-in-practice perspective indicates that norms indicate about how algorithms should be used, 'norms' was used as a code to identify corresponding social action reported in the interviews and in the documents. Lower-level codes such as the norm 'algorithms should be used to improve policing effectiveness' were derived inductively. In this way, the conceptual lenses were filled with empirical material and the patterns of algorithmization were carved out.

Findings

Use of KrimPro by the Berlin Police

Facilities: Components of Algorithmization. The Berlin predictive policing system KrimPro is a system for temporal-geographical analyses of crime patterns. These analyses form the basis for the allocation of police resources to areas that are deemed at high-risk for domestic burglaries. The Berlin police staff division that operates KrimPro uses the system to divide the territory of Berlin in about 4.500 quadrants each of which is 400 by 400 m. For every quadrant a risk-score is estimated on each working day. The selected areas remain labeled as at high-risk for 3 days. These high-risk clusters are displayed on a map of Berlin. Additional map sections provide a more detailed account of the high-risk areas. For each selected quadrant, a risk-score is displayed and the quadrant is colored accordingly.

The staff department distributes the maps with the color-coded quadrants in pdf format to the local departments across Berlin's districts and to departments with coordinating functions. In the local departments, the information is further processed, by information analysts and criminal police commissars. The commissars make operational decisions, inter alia, based on the information supplied by KrimPro, whereas the information analysts only have a supportive role. They assess the predictions for the operational police work critically and put them into the context of other available information (I6.1).

The facilities of KrimPro in the Berlin Police can be understood along the lines of the six components of algorithmization. The predictive policing system was developed by the Berlin Police as a tool for rationalizing the allocation of police resources (*technology*). KrimPro is used by both statistic experts at the staff division and by information analysts at the local departments; working with the

system becomes an important element in their work (*expertise*). The system uses police information (e.g. characteristics of known offenses) as well as publicly available information (e.g. information on demography from the regional statistical office) (*information relations*). KrimPro has become an integral element in procedures for information exchange between the staff department and the local and coordinating departments (*organizational structure*). The Berlin Police has developed formal procedures for the system that highlight responsibilities and integration in organizational routines (*organizational policy*). Finally, the Berlin Police periodically monitors how KrimPro is being used and adjusts the system on the basis of these assessments (*monitoring and evaluation*).

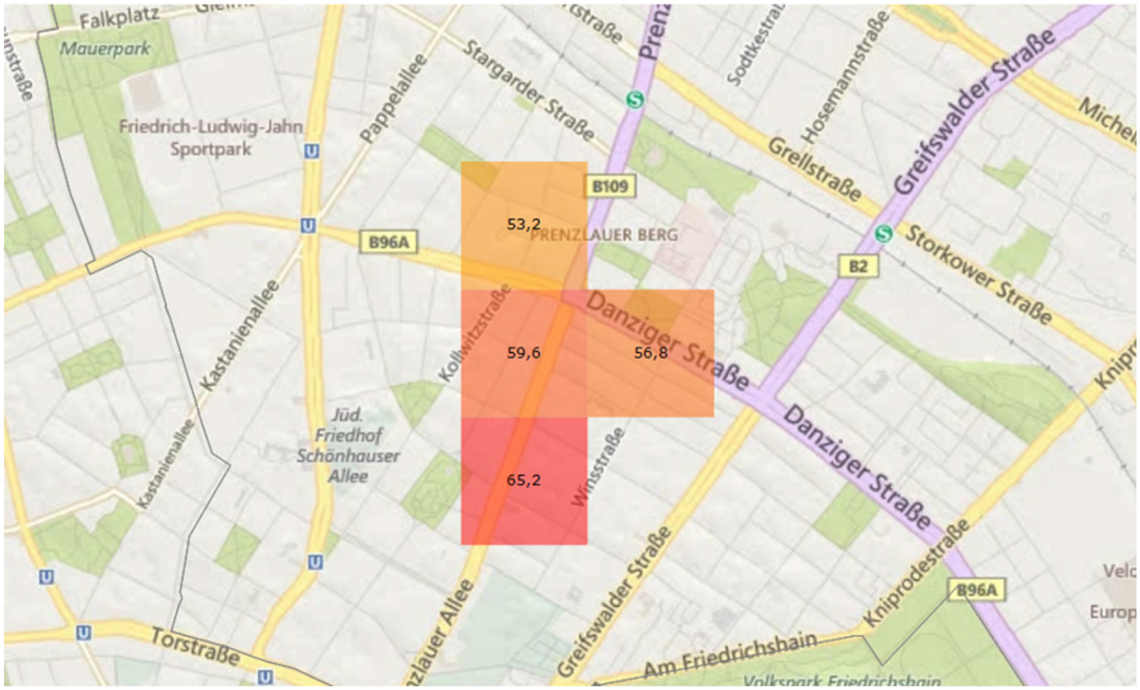
This analysis of facilities highlights that KrimPro is a predictive policing system with a focus on identifying crime hot spots to allocate police resources more effectively. The system is managed by a specific staff department that holds a key position in analyzing data and identifying high crime areas. Access to the system itself is limited for local departments: they receive a static map in pdf format. In addition, for the entire city state's territory, only up to three areas consisting of a few quadrants with high risk scores are selected. This reduces the amount of information in the output and therefore the need, but also the opportunity, for interpretation in the subsequent process (Figure 1).

Norms and Values. The police leadership has made the use of KrimPro in the decision-making processes obligatory by 'institutionalizing' (I6.1, 20) the ways of working with the system. By distributing the different work steps (e.g. producing and distributing predictions, evaluation, and decision-making) vertically across police divisions, each of them become a part of a larger processing chain. The use of KrimPro is facilitated by linking the acceptance of the predictive policing system as a valid source of information, to the promotion of the norm that usage of the information from the system is good police practice.

The norm that KrimPro needs to be used to establish more effective policing is contested, especially because the probability-based functioning of the system differs greatly from the traditional detective work. Moreover, in the local departments, the interference of the department that operates KrimPro in the decision-making on police deployment is contested. "They have a bit of a problem with that a department that has actually nothing to do with the analysis for operative purposes has developed this approach and tells them now how it is actually done best or differently." (I1) In fact, a respondent from a local department distanced himself and his division from the system and claimed "That (KrimPro) is something from the LKA. It has been imposed on us here." (I2).

This analysis highlights the contested nature of the norms for using the predictive policing system. The higher hierarchical levels emphasize that the system needs to be used and see it as a form of rationalizing the organization. The local departments feel that the system is being 'imposed' upon them and see limited value in the system. The tension between centralized steering and local operations manifests itself in different perspectives on the use of the system in the Berlin Police.

Interpretative Schemes. Employees in the local departments regard KrimPro as a 'black-box' (I2) since no specific training regarding the use of a predictive policing system was given (I1, I5.1). One respondent states that training courses, to my knowledge, were also not necessary because the program itself is just operated by the LKA St 14 department. However, even information analysts indicated



Source: Polizei Berlin. The numbers indicate risk cores.

Figure 1 Image from the KrimPro System in Berlin

that they had no or very little understanding of the system's functioning (I3). This perception seems to be at odds with the critical assessment of the predictions by the information analysts as expected by the police leadership (I1).

In addition, respondents perceive strong organizational pressure to follow KrimPro's advice. Simply not trusting the information provided by the predictive policing system is not considered to be a valid reason for rejecting it (I4.1). Following KrimPro is the easier legitimation strategy, "I do not risk anything because even if I find it stupid and nothing happens there or even if something happens, it will not be my responsibility. I have not done anything wrong." (I1) In addition, use of the system comes with a reward: the availability of more human resources and this is perceived by some respondents as the most positive aspect of KrimPro, "Before (KrimPro) a head of a local inspection for domestic burglary did not get additional police forces. It was unthinkable in the past that one can steer the mobile squats like that. And now it happens very often." (I4.1).

Furthermore, all police operations in areas with a predicted high-risk of crime are documented and stored in a database (I4.1). This has been implemented to evaluate the predictions but it also enables the monitoring of decision-making processes. It makes it traceable which police divisions reacted in what ways to the information given by the predictive policing system. A deviation from this standard can probably only be achieved against all odds and with additional justification. "That is not an easy position for anyone who actually really rejects this system because there is always some kind of pressure, even if it is not clearly legally formulated: you have to do this." (I1).

The analysis of the interpretative schemes highlights that 'resistance is futile': most respondents feel that, even though they cannot grasp the inner workings of the system, they need to use it. The idea that the information from the system needs to be checked against other forms of (contextual and informal) knowledge does not hold in a practice with a variety of organizational pressures to blindly follow the system.

Use of the Crime Anticipation System by the Amsterdam Police

Facilities: Components of Algorithmization

The Crime Anticipation System (CAS) is a predictive policing system that provides forecasts of areas with a statistically higher chance of crime. On a geographical map, the system displays grids of 125 × 125 m with chances of criminal incidents in a specific timeframe. Higher risk areas are indicated on a heat map with three colors: yellow for a slight increase, orange for a moderate increase, and red for a high increase in chance.

CAS is relatively modifiable: specific crime types can be (de) selected, and users can decide whether CAS should display a top-25 or top-10 of higher risk areas on the heat map. Within the Dutch police, intelligence specialists are the main users of CAS. Intelligence specialists use CAS in weekly advisory reports and daily briefings they develop for the operational level of the organization: street-level officers. CAS requires that intelligence specialist filter the information before presenting it to the street-level officers. The outcome of CAS has a fixed position in the template of the advisory reports and briefings.

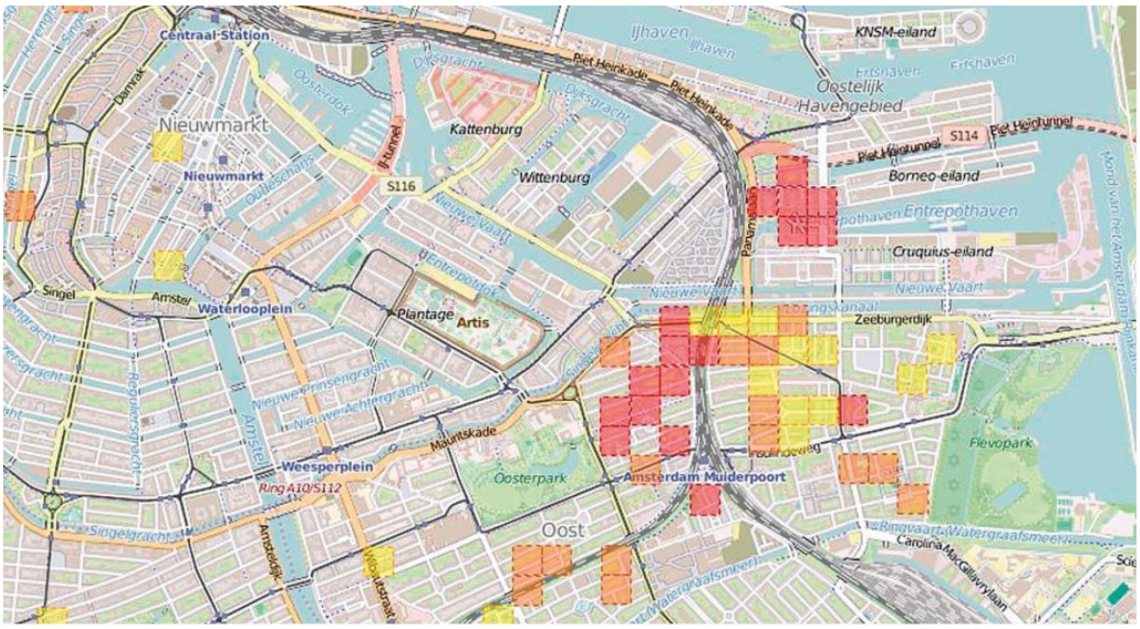
The facilities of CAS for the Amsterdam Police can be understood along the lines of the six components of algorithmization. CAS is introduced as a decision-support system (*technology*) and assist intelligence specialists have developed the expertise to work with it (*expertise*). CAS builds upon pre-existing information within the organization—police data—but also incorporates public accessible data—socioeconomic data (*information relations*). CAS has become embedded in pre-existing organizational structures through the working procedures for advisory reports and daily briefing to operational officers (*organizational structure*). The organization has developed a policy that stipulates how CAS is to be used in capacity planning procedures (*organizational policy*). Finally, the organization monitors three aspects of CAS (*monitoring and evaluation*): technical monitoring (back end of the system), functional monitoring (interface of CAS), and monitoring of usage.

This analysis of the facilities of the CAS highlights generic features of predictive policing systems: a focus on areas with higher occurrences of crime that are projected on a 'heat map' based on an analysis of both open data and police data. CAS is a system for intelligence specialists who use the system for their weekly advisory reports and daily briefings. This means that the system is 'invisible' for most of the organization but still influential since it is used for the reports and briefings that are used to plan the work (Figure 2).

Norms and Values. In the interviews, it became clear that the specialists wield high professional norms in respect to developing advisory reports and briefings for the street-level officers. To illustrate, an intelligence specialist mentioned "I think it is my core task, the upmost important task, to guide my colleagues safe as possible in the streets. […] For me it is mainly about the safety of my colleagues" (I06). Intelligence specialists also actively verify whether their advice was useful. One respondent, for example, indicated that s/he frequently asks colleagues whether the operational coordinators have actually deployed officers based on his/her advice (I09). This shows that co-production is a key norm for the intelligence specialists, "I can try to force something else through, but if the need is not there then you are doing it for nothing. […][We] discuss together about what we put in [the advice] and how we put it in. […] It is ultimately a product you are making for the whole [operational] team." (I02).

The intelligence specialists sometimes have the tendency to refrain from adding CAS to the daily briefing, as this does not always help to convince street-level officers what they should look for during their shift, "Some people really make these CAS maps and put it on the briefing but […] it can be different every day so you have to put in a new map every day. And that is possible but […] we see that it […] does not have much effect to the colleagues for whom you are making the briefing." (I02). Thus, the norm is not to showcase the system but to provide information in a useful and convincing manner.

Although the output of CAS—the heatmap—has a dedicated position in the template of the advisory reports, it does not replace the knowledge or experience of the intelligence specialists. The



Source: TNO. Red: high risk score, orange: intermediate risk, yellow: low risk.

Figure 2 Image from the CAS in Amsterdam

police organization stresses the importance that the output of CAS should be enriched with the tacit knowledge of the intelligence specialists, "I am being asked to enrich [the] information, enhance it, and to publish that. So to disseminate it to [my] colleagues. But also a lot comes out of myself: I see things, observe [things], and that is what I share with my [street-level] colleagues." (I06).

The analysis of norms and values shows that there is extensive interaction between CAS, the experiences and knowledge of the intelligence specialists, and the perceived value of the advisory reports and briefings to street-level officers. The system is seen as valuable when it supports the collaborations between information specialists and operational officers. Collaboration, couleur locale, and combining formal and tacit information are key organizational norms rather than strictly following the system's output.

Interpretative Schemes. Intelligence specialists consider CAS as a helpful tool to gain a quick overview of possible future trends, "Before, our core business was always looking back: […] where did [crime] occur and say something intelligent about it. Now, based on […] looking back what data we have […] but also […] expectations, patterns, you name it. You try to look forward and that is something that […] you cannot do as quickly as CAS [can]" (I12). CAS is currently the only system that can provide intelligence specialists with future trends, so they are welcoming these predictive insights that only this system can currently offer.

The vast majority of the interviewed intelligence specialists perceive CAS as a system that can help them in their practices. Intelligence specialists seek interaction between their own insights and knowledge, and the information from CAS. Hereby, it is argued that it can help with filling blind spots and presumably helps intelligence specialists developing better advisory reports, "I think it is best if CAS provides [me with] a completely different picture. Because at the moment that he presents another picture, that means that I need to look in a completely different manner what is going on. (I10)".

In contrast to the positive perceptions of CAS from a dominant group of information specialists, a minority do not perceive any added value of using CAS. These intelligence specialists do not incorporate the output of CAS in their advice, but only add it because of organization directives, "If you look at our presentation, is CAS really on the final slide. Like: this is our presentation and this is what CAS is saying." (I08). These intelligence specialists see more value in their own tacit knowledge than the information that CAS provides, "My advice is not based on CAS. [It] is based on the facts we are experiencing, which we are seeing. And also looking to the past, so a sort of CAS but that is then purely out of yourself, out of the experience from other years: certain periods we know that certain things will happen."(I06).

This analysis shows that two main interpretive schemes are recognized within the Amsterdam police organization: a larger group of intelligence specialists are predominantly positive about CAS and use it as a complementary tool, and a smaller group that is skeptical and only use it superficially because of organizational procedures. A methodological reflection is that the smaller group may actually be larger than we found in the research since respondents who are positive about CAS may have been more eager to participate in the research. The key difference between the groups is whether the information from CAS is seen as a valuable addition to the existing sources and tacit knowledge or whether it is regarded as an organizational 'fad' that is inferior to their professional knowledge.

Comparative Analysis and Discussion

Both case studies provide rich insights in the use of algorithmic systems in a bureaucratic organization and there are many

similarities but also differences in the patterns of algorithmization. In this section, we will indicate which similarities and differences can be identified in the patterns of algorithmization in two different contexts.

The analysis of the *facilities* highlights that these two predictive policing systems are highly similar: both police departments have developed predictive policing system that provides forecasts of areas with a statistically higher chance of crime to rationalize the allocation of police resources. Both systems combine public information (e.g. on demography) with police information on crime patterns. The processes of algorithmization in both police departments highlight that the introduction of these systems resulted in a broad set of organizational changes related to the expertise of information specialist, the types of information to be used, the structures for planning the allocation of police resources, the policies how to use the system, and the monitoring and evaluation of how the system works and performs.

Even though the facilities are largely similar, the *norms* for using the system turn out to be quite different. A key aspect here concerns the use of tacit knowledge. Superficially, there seems to be a similarity between the two police departments in the sense that they both stipulate that information from the predictive policing system needs to be combined with other, often tacit, forms of knowledge. At the deeper level, however, our analysis highlights that the room in Berlin to diverge from the system is much more limited than in Amsterdam. The dominant norm in Berlin is that the system should be used, whereas the norm in Amsterdam is that the system should add value to the broader informational analysis.

And also in the *interpretative schemes* we see substantial differences between the two police departments. Again, superficially there seem to be similarities. In both police departments, we see that the use of the predictive policing system is contested. In Berlin, some local departments see the system as a tool used by the centralized staff department that is hardly useful for their practices. In Amsterdam, some intelligence specialists highlight that their own tacit knowledge provides a better rationale for allocating police resources than the formal system. In both countries, some respondents regard the system as a 'fad' that will disappear over time rather than a permanent change in their work. At the deeper level, however, we see that the options for intelligence specialists to resist organizational pressures are different. The Berlin Police enforces the use of the system and exerts pressure on departments that are reluctant to use the predictive policing system. Our analysis highlights how the Berlin police builds upon a surveillance logic to ensure organizational compliance. By tracking police operations, the organization traces deviations from the standard and reinforces the standard. This surveillance logic was not present in Amsterdam: the police largely urged rather than forced intelligence specialists to use the system. The Amsterdam Police positions the system as an aid in a collaborative relation between intelligence specialists and operational officers and highlights the 'coproductive' nature of this collaboration.

This comparative analysis shows that technologically similar systems result in different organizational patterns. The use of KrimPro in Berlin results in stronger hierarchical relations: the hierarchy is restructured into an 'algorithmic cage' in which organizational power is exerted through the algorithmic system. In Amsterdam, the system is positioned in more horizontal relations and the system can be regarded as an 'algorithmic colleague' who provides sensible advice, which is considered vis-à-vis a variety of—formal, contextual, and tacit—forms of knowledge. These patterns are widely in line with the cultural differences between police organizations in Germany and the Netherlands with more emphasis on hierarchy and procedures in Germany and more emphasis on autonomy and professional judgment in the Netherlands. As such, differences in the emerging patterns of algorithmization can be attributed to the context of application rather than the nature of the technological system.

Conclusions

This paper set out to enhance our understanding of the relation between algorithm and organizational context. Building upon the socio-technical perspective on algorithms (Beer 2016; Kitchin 2017), this study introduced the concept of algorithmization as an emerging process in a specific organizational context rather than just the implementation of an instrument. We used this concept to study the emerging patterns of algorithmization in two different empirical settings: the Berlin Police and the Amsterdam Police.

The empirical expectation underlying the research was that similar systems (in terms of their facilities) can produce different outcomes when used in different organizational settings (in terms of the norms and interpretations). Our study of the use of predictive policing systems in Berlin and Amsterdam indeed provided support for this expectation: the use of highly similar systems resulted in more hierarchical forms of organization in Berlin, whereas the introduction of this system generated more room for professional information specialist in Amsterdam. This confirms that the use of similar systems can reinforce different organizational forms and we labeled these outcomes as the 'algorithmic cage' and the 'algorithmic colleague'.

The algorithmic cage means that existing forms of bureaucratic control are strengthened by the algorithmic system and this pattern mirrors what Buffat (2015) refers to as the 'curtailment thesis'. In Berlin, the integration of the algorithmic system in work processes was enforced through hierarchy and procedures (Green and Rossler 2019). Rejecting the use of KrimPro potentially goes against central norms of the profession, requires additional information, expertise, and justification, as well as potentially increases the risk of being held accountable. The use of the system standardizes work routines, centralizes decision-making, and increases the level of control within the organization. Following the advice of the predictive policing system is the safe option for employees.

The algorithmic colleague is a pattern that Buffat (2015) refers to as the 'enablement thesis': the existing patterns of professional judgment are being strengthened by the use of the algorithmic system. One could argue that this means that the systems are not integrated in the organization (Green and Rossler 2019) but the empirical research provides a more nuanced perspective: the information is used based on professional expertise. In Amsterdam, the information specialists had considerable discretion in using the system and combining it with their own knowledge. The system

was largely an instrument for further professionalizing the position of the information specialist in the police organization. Using the system as a relevant source of information in combination with other sources is what is expected from information professionals in the organization.

In line with other comparative research into the relationship between administrative culture and technology (Zhang and Feeney 2020), our comparative research suggests that the emerging types of algorithmization are linked to different administrative cultures. We selected Germany for having a stricter focus on bureaucracy, standardization, and hierarchical relations and indeed we found the pattern of the algorithmic cage. In contrast, we selected the Netherlands for having more professional autonomy and we found the pattern of the algorithmic colleague. Our explorative study thus provides support for the influence of administrative culture on emerging patterns of algorithmization. A further understanding of the relation between cultural and institutional context and emerging patterns of algorithmization requires much more systematic empirical work and the analysis of organizational usage of predictive policing systems in different countries. The divergence thesis that we can formulate on the basis of our research—algorithmization in hierarchical administrative cultures results in more bureaucratic control, whereas algorithmization in less hierarchical cultures results in more support for professional judgment—needs to be investigated further through comparative research.

The research presented in this paper helps to nuance debates about the biases of predictive policing systems (Katzenbach and Ulbricht 2019; Tutt 2017). The empirical research highlights that biases may be mitigated by the way the system's use in an organizational context. If the police organization encourages professional use of the system and combination with other sources, as we have seen in Amsterdam, the bias in the predictive policing system may be corrected. If the police organization, however, puts a strong emphasis on following the algorithm, as we saw in Berlin, this mitigation of the algorithmic bias may not occur. This means that the bias of predictive policing systems should be assessed as an organizational outcome rather than a technological feature.

In previous work by legal scholars, the legitimacy of predictive policing has been explored (Simmons 2018). The implications of our organizational perspective for the contribution of algorithms to police legitimacy shed a new light on this discussion since two contrasting legitimacy claims appear in this paper. The claim from the Berlin Police is the well-known claim of rationalization through modern technology: a rational police organization based on algorithms is claimed to be legitimate. The claim from the Amsterdam Police is that legitimacy in the end depends on the quality of the work of police professionals: equipping professionals in the police with better algorithmic tools will result in more legitimacy. More (contextual and comparative) research is needed to further unpack and investigate these contrasting legitimacy claims (see Reddy, Cakici, and Ballestero 2019 for a similar contextual approach).

This paper specifically focused on the use of algorithmic systems in the police but the study adds to our general understanding of the algorithmization of bureaucratic organizations. The study highlights that this process should not be understood as being deterministic in the sense that algorithms impose one model of bureaucratic organization. The study highlights that at least two different emerging patterns can be identified—the algorithmic cage and the algorithmic colleague—and that these emerging patterns depend on the social norms and interpretations that are connected to the facilities of algorithmic systems.

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