9. Better technological security solutions through human-centred design and development

Andrew B. Wootton, Caroline L. Davey, Dagmar Heinrich and Maximilian Querbach

1. INTRODUCTION

The Design Against Crime Solution Centre at the University of Salford has spent the last two decades undertaking action research around design-led crime prevention. The authors have focused on the role of design – of products, communications, processes, systems and environments – in reducing harm and improving safety and security. This has included research into the analysis and mapping of police-recorded crime incident data to better target preventative action by law enforcement and partner agencies. As proponents of human-centred design, the authors have been critical of overly *technology-driven* approaches that tend not to fully consider contextual requirements, roles, values and responsibilities of the human stakeholders within a design system. The rise of big data analytics might be considered a prime example of a *solution* emerging from a technological development – a capability searching for a well-defined problem.

Much has been written about the application of big data analytics to law enforcement, often in what has been termed *predictive policing*.[1] Predictive policing is traditionally defined as,

> a multidisciplinary, law enforcement-based strategy that brings together advanced technologies, criminological theory, predictive analysis, and tactical

---

[1] Dennis Broeders and others, 'Big Data and Security Policies: Towards a Framework for Regulating the Phases of Analytics and Use of Big Data' (2017) 33 Computer Law and Security Law Review; Andrew Guthrie Ferguson, *The Rise of Big Data Policing* (New York University Press 2017); Pietro Costanzo, Francesca D'Onofrio and Julia Friedl, 'Big Data and the Italian Legal Framework: Opportunities for Police Forces' in B Akhgar and others (eds), *Application of Big Data for National Security* (Oxford 2015).

operations that ultimately lead to results and outcomes – crime reduction, management efficiency, and safer communities.[2]

In 2019 Meijer and Wessels further, and arguably more practically, defined predictive policing as,

> 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 in developing policing intervention and prevention strategies and tactics.[3]

While the focus was initially on the potential for predictive policing to modernise and improve policing, later studies highlighted the ethical, legal and social impacts of the approach.[4]

This chapter draws on research carried out as part of the EU-funded *Cutting Crime Impact* (CCI) project. The overall aim of the CCI project was to prevent high-impact crime and reduce its negative effect on citizens through the use of a human-centred design approach.[5] The focus of CCI was directed by six partner law enforcement agencies (LEAs), with the aim to develop tools that met their needs and requirements. Consequently, CCI addressed four LEA-defined 'focus areas' related to the prevention of crime and insecurity. The focus area chosen by the Landeskriminalamt (LKA) in Lower Saxony, Germany, was predictive policing. The LKA was supported in adopting a human-centred design approach to address issues around predictive policing in Lower Saxony.[6]

This chapter details CCI research in Lower Saxony into the application and use of predictive policing, undertaken using a human-centred design approach. Research conducted in Lower Saxony revealed that the new system was not actually transforming police operations in the way it was planned. Using a human-centred design approach, the LKA was able to better understand and reframe the problem, as well as develop a solution tailored to the needs of end-users.

---

[2]   Craig D Uchida, 'Predictive Policing' in Gerban Bruinsma and David Weisburd (eds), *Encyclopedia of Criminology and Criminal Justice* (Springer 2014) 3871.

[3]   Albert Meijer and Martijn Wessels, 'Predictive Policing: Review of Benefits and Drawbacks' (2019) 42 International Journal of Public Administration, 1033.

[4]   Oskar J Gstrein, Anno Bunnik and Andrei Zwitter, 'Ethical, Legal and Social Challenges of Predictive Policing' (2019) 3 Católica Law Review 77.

[5]   CCI, 'Introduction to CCI' (cuttingcrimeimpact.eu, 2021) <https://www.cuttingcrimeimpact.eu/about/introduction-to-cci/> accessed 7 July 2022.

[6]   ibid.

2.   THE DESIGN APPROACH TO RESEARCH

The *Design Against Crime Solution Centre* undertakes design research within the broad domain of safety and security. As a means of creating tools, processes and systems that support the security goals of end-users, adopting a design approach offers several benefits.

For designers, the needs of the human user are central to understanding problems, evaluating options and resolving issues – an approach often described as *human centred*:

> human-centred design focuses on the roles, requirements, abilities and perceptions of all the humans in the problem domain being examined.[7]

The CCI project adopted a human-centred design approach to the delivery of tools for its partner LEAs, focusing on the human participants within the various design systems being studied – in this case, LEAs and their stakeholder organisations.[8] From a human-centred perspective, the application of predictive policing must respect the requirements and values of the humans in the design system. In order to do so, designers must gain insight into end-users' needs, limitations and contexts.

2.1   Human-centred Design

As in other disciplines, design is characterised by a specialised vocabulary that illuminates certain aspects of the lived experience and constructs a particular worldview. This design discourse resides in the work of communities of academic and professional practice.[9] The design literature identifies at least four key features that in combination might be considered distinctive of design and which the authors suggest are fundamental to design research.

1.   Design explores possible futures while producing tangible results
     Designers have the ability to imagine and convincingly communicate possible futures, explore different means of pursuing such futures,

---

[7]   Caroline L Davey and Andrew B Wootton, *Design Against Crime: A Human-Centred Approach to Designing for Safety and Security* (Routledge 2017) 30.
[8]   CCI, 'Project Design' (cuttingcrimeimpact.eu, 2021) <https://www.cuttingcrimeimpact.eu/about/project-design/> accessed 4 August 2022.
[9]   Klaus Krippendorff, 'Design Discourse: A Way to Redesign Design' [1998] Keynote Address to the Society for Science of Design Studies 6 December 1998 01–5 <https://repository.upenn.edu/asc_papers/227> accessed 29 June 2022.

and work towards achieving those that are chosen. In the process, a stockpile of meaningful artefacts is amassed, such as sketches, drawings, models and specifications.[10] The role of design in addressing societal challenges and helping create improved and more sustainable solutions is emphasised within a range of design approaches, including socially responsible design and transformation design.[11]

2. Design challenges assumptions to provoke new perspectives and ideas

Designers pursue possibilities for change, overcoming barriers and opening doors that appear closed. In pursuing change, designers challenge what others take for granted, creating space for new ideas and for improvement.[12] Indeed, the process of challenging assumptions is often a form of *provocation* aimed at exposing alternative perspectives and new ideas, rather than being a solution itself.

3. Design is human-centred, embracing the depth and diversity of human experience

For designers, the needs of the human user are central to understanding problems, evaluating options and resolving issues – the essence of being *human-centred*.[13] Design research seeks to embrace the diversity of practical, psychological and emotional understandings that humans bring to artefacts and situations. This draws on empathetic observation, visual and physical prototyping, and creative analysis to gain rich understanding and insight.

Human-centred design moves beyond ergonomics or human factors approaches, which traditionally focus on efficiency of use, perceptual biases and mistakes. Designers appreciate the social and psychological impact of their work; how the creation of new artefacts alters how we live together. As Krippendorf identifies, 'We do not react to the physical properties of things but act on what they mean to us.'[14]

Unlike other change-oriented disciplines, such as engineering, design is primarily concerned with the creation of artefacts that are

---

[10]   ibid.
[11]   Caroline L Davey and Andrew B Wootton, 'Transformation Design – Creating security & wellbeing' in Wolfgang Jonas, Kristof Von Anshelm and Sarah Zerwas (eds), *Transformation Design* (BIRD 2016).
[12]   Krippendorff (n 9).
[13]   Davey and Wootton (n 7) 11.
[14]   Krippendorff (n 9) 8.

perceived as meaningful by others.[15] Thus, empathy and emotional intelligence are important design research skills.

4. Design involves prototyping and progressive refinement

Design research involves controlled revelation of research outputs to the world to test if and how they function, and then progressively refining them.[16] Product designers refer to prototyping – which may suggest a physical product, test rig or *demo*. However, there are numerous forms of 'prototyping' in design research – from narrative descriptions, through drawings and conceptual models, to three-dimensional models and data analyses. These may all be used to test, validate and refine outputs of design research.

2.2 Human Centred vs Technology Driven

The results of human-centred design contrast with technology-driven solutions, which, as identified by the Technology Hype Cycle,[17] often fail to meet early expectations. Predictive policing is perhaps a prime example of a technology-driven solution,[18] with a number of police forces reducing or ending their use of predictive policing technologies.[19] For instance, Kent Police – the first UK police force to try predictive policing – ended its £100,000 per year contract in March 2018, after five years. While PredPol – the system deployed – was considered to have a good record in predicting the location of crime, there was no evidence that this information was being used to actually reduce crime.[20]

---

[15] Richard Buchanan, 'Declaration by Design: Rhetoric, Argument, and Demonstration in Design Practice' in Victor Margolin (ed.), *Design Discourse: History, Theory, Criticism* (The University of Chicago Press 1989).

[16] Allan Collins, Diana Joseph and Katerine Bielaczyc, 'Design Research: Theoretical and Methodological Issues' (2004) 13(1) The Journal of the Learning Sciences.

[17] Ozgur Dedehayir and Martin Steinert, 'The Hype Cycle Model: A Review and Future Directions' (2016) 108 Technological Forecasting and Social Change.

[18] Guy Adams 'LAPD's sci-fi solution to real crime' *Independent* (London, 11 January 2012) 32.

[19] Johana Bhuiyan, 'LAPD Ended Predictive Policing Programs amid Public Outcry: A New Effort Shares Many of Their Flaws' *The Guardian* (8 November 2021) <https://www.theguardian.com/us-news/2021/nov/07/lapd-predictive-policing-surveillance-reform> accessed 2 August 2022; Annie Gilbertson, 'Data-Informed Predictive Policing Was Heralded As Less Biased. Is It?' *The Markup* (NY, 20 August 2020) <https://themarkup.org/the-breakdown/2020/08/20/does-predictive-police-technology-contribute-to-bias> accessed 2 August 2022.

[20] Patricia Nilsson, 'First UK Police Force to Try Predictive Policing Ends Contract' *Financial Times* (London, 26 November 2018).

From a human-centred perspective, the application of predictive policing needs to respect the needs, requirements and values of the humans in the design system. Design outputs, such as tools, must be designed to support the roles and actions of those humans within a system who are responsible for its successful implementation and/or delivery. Consequently, human-centred objectives rather than technology should drive the design process, these being:

1. To enhance human abilities
– *Human abilities should be identified, understood and cultivated*
2. To overcome human limitations
– *Identify these and devise compensatory mechanisms/processes*
3. To foster human acceptance
– *Understand and address preferences, concerns and values.*[21]

To do this, requires deep insight into end-users' needs, requirements and contexts. LEA partners in the CCI project were supported to undertake design research to gain such insight about the design systems upon which their problem areas focused. As outlined above, the focus of design research is not merely data, but insight gained from research into stakeholder needs and contexts.[22] Such insight can act as the catalyst for new ways of thinking about problems or issues, from which successful solution ideas can be developed.[23] This search for insight requires not just the social science skills of the ethnographer, but also empathy, introspection and emotional intelligence.

3. GREAT EXPECTATIONS: PREDICTIVE POLICING AND BIG DATA

In recent years, considerable attention has been given to big data, and claims for its potential value to business,[24] science and medicine.[25]

---

[21] William B Rouse, *Design for Success: A Human-Centered Approach to Designing Successful Products and Systems* (Wiley 1991).

[22] Davey and Wootton (n 11) 62.

[23] ibid.

[24] Andrew McAfee and Erik Brynjolfsson, 'Big Data: The Management Revolution' (Harvard Business Review, October 2012) <https://hbr.org/2012/10/big-data-the-management-revolution> accessed 6 April 2022.

[25] Mary Mallappallil and others, 'A Review of Big Data and Medical Research' (2020) 8 SAGE open Med 1.

Big data analytics is the use of advanced analytic techniques to analyse large and diverse data sets coming from different sources. Such data may be structured, semi-structured or unstructured, and range in size from terabytes to zettabytes.[26] Big data is characterised by high data volume, data velocity and data variety – the so-called '3V definition'.[27] Such big data sets must be managed by computer networks geared towards the processing of high volumes of data messages with minimal delay.[28] Sources are more complex than traditional sources of data, being often the output of artificial intelligence (AI), mobile devices, social media and the Internet of Things (IoT).[29]

3.1   The Original Promise of Predictive Policing

Big data analytics is a technology that promises to fuel better and faster decision-making, modelling and predicting future outcomes, and providing enhanced business intelligence.[30] Recognising its potential to support decision-making in the field of law enforcement, products using big data analytics were developed for police forces and marketed under the term *Predictive Policing*.

While large companies like IBM also make predictive policing tools, one of the most widely deployed products in the US comes from a small company in Santa Cruz.[31] The sales literature identifies a range of uses for predictive policing – a list of technological *could do*s. However, in essence, predictive policing is quite simple. Core to predictive policing is a product, or more specifically a software application, designed to analyse past crime data, in terms of the type of crime, when it happened and where. Based on

---

[26]   IBM, 'Big Data Analytics' (IBM.com, ND) <https://www.ibm.com/analytics/big-data-analytics> accessed 6 April 2022.

[27]   Doug Laney, '3D Data Management: Controlling Data Volume, Velocity and Variety' Gartner (2 February 2001) <https://studylib.net/doc/8647594/3d-data-management--controlling-data-volume--velocity--an…> accessed 14 July 2022; Rosamunde van Brakel, 'Pre-Emptive Big Data Surveillance and its (Dis) Empowering Consequences: The Case of Predictive Policing' in Bart van der Sloot and others (eds), *Exploring the Boundaries of Big Data* (Amsterdam University Press 2016).

[28]   Salvador García and others, 'Big Data Preprocessing: Methods and Prospects' (2016) 1(9) Big Data Analytics.

[29]   IBM (n 26).

[30]   ibid.

[31]   Alexis C. Madrigal, 'The Future of Crime-Fighting or the Future of Racial Profiling? Inside the Effects of Predictive Policing' (HuffPost.com, 28 March 2016) <https://www.huffpost.com/entry/predictive-policing-video_n_56f898c9e4b0a372181a42ef> accessed 5 April 2022.

an analysis of this data, predictive policing systems generate more or less accurate predictions about where and when future crimes are more likely to occur.[32] Systems may be used to predict individuals at risk of offending (or reoffending) or to identify locations where crime is likely to occur[33] – the latter being the focus for this chapter.

In relation to some products, such as PredPol (used in the US and UK),[34] the system represents predictions in terms of 150 metre square red boxes overlaid onto a Google map. These red boxes are the areas at risk of crime that police officers should patrol, when they are not actively responding to a call. By focusing their attention on areas where there is a higher likelihood of crimes being committed, it is argued, patrolling efforts will be more effective and the number of crime incidents in that location will be reduced.

The new technology and its application of predictive policing to law enforcement was heralded as ground-breaking. Indeed, in 2011 *TIME* magazine named predictive policing – and its application in the city of Santa Cruz – as one of the 50 best inventions of that year.[35] Santa Cruz's Police Chief Kevin Vogel said of the accolade,

> We are honored to be recognized by Time magazine for our predictive policing program[.] Innovation is the key to modern policing, and we're proud to be leveraging technology in a way that keeps our community safer.[36]

The new technology was credited with making police operations more effective, without requiring additional resources. According to Zach Friends, a spokesman and crime analyst for the police department, 'since the program was implemented, the department has seen a large reduction in crimes.'[37]

---

[32] ibid.

[33] van Brakel (n 27).

[34] PredPol 'Predictive policing: The Predictive Policing Company' (2015) <www.predpol.com> accessed 18 July 2022; Kentonline, 'Predpol Software which Targets Crime Down to Small Zones Has Slashed North Kent Crime by 6%' (Kent, 2013) <www.kentonline.co.uk/kent/news/crime-innorth-kent-slashed-4672> accessed 18 July 2022.

[35] Jessica M. Pasko, 'Time Magazine Names Santa Cruz Police Program to Predict Crime One of the Year's Top Inventions' *The Mercury News* (Santa Cruz, 23 November 2011) <https://www.mercurynews.com/2011/11/23/time-magazine-names-santa-cruz-police-program-to-predict-crime-one-of-the-years-top-inventions/> accessed 6 April 2022.

[36] ibid.

[37] ibid.

Most senior police officers would probably like to be able to demonstrate that their force has become more effective, while spending less.[38] More likely than not, senior police officers are also under pressure to modernise and address specific issues – often identified by those outside the force, responsible for local or national policies. Like other organisations, police senior managers are influenced by current trends in organisational management and change, as well as the hype that often seems to surround a new technology.[39] Under the circumstances, it is perhaps not surprising that police forces in the US were willing to risk experimenting with the new technology.

Predictive policing was first piloted by the Los Angeles Police Department (LAPD) in 2010,[40] with the city of Minneapolis an early adopter of the approach.[41] Other cities in the US soon followed, with New York City Police Commissioner William Bratton calling predictive policing 'the wave of the future'.[42] Police forces across the world rushed to adopt the use of data analysis methods to inform deployment of police resources, often reduced due to public spending cuts after the 2008 financial crisis. Deemed innovative and forward looking, predictive policing was heralded as the beginning of a new era in 21st-century policing by politicians and police leaders alike.[43] According to a report funded by the US Department of Justice, by 2017 28% of large US police agencies were using predictive analytics software, with a further 22% planning to implement it by 2019.[44] Predictive policing was also considered *promising* for LEAs

---

[38]   HV Jagadish, 'The Promise and Perils of Predictive Policing Based on Big Data' (TheConversation.com, 16 November 2016) <https://theconversation.com/the-promise-and-perils-of-predictive-policing-based-on-big-data-48366> accessed 6 April 2022.

[39]   ibid.

[40]   Gstrein and others (n 4).

[41]   Jeff Egge, 'Experimenting with Future-Oriented Analysis at Crime Hot Spots in Minneapolis' (2011) 2(4) Geography & Public Safety <https://www.ojp.gov/ncjrs/virtual-library/abstracts/experimenting-future-oriented-analysis-crime-hot-spots-minneapolis> accessed 7 April 2022.

[42]   Ali Winston, 'Predictive Policing is "Wave of the Future," NY Commissioner Says' (revealnews.org, 31 July 2015) <https://revealnews.org/article/predictive-policing-is-wave-of-the-future-ny-commissioner-says/> accessed 7 April 2022.

[43]   Beth Pearsall, 'Predictive Policing: The Future of Law Enforcement?' (2010) 266 National Institute of Justice Journal <https://www.ojp.gov/pdffiles1/nij/230414.pdf> accessed 3 August 2022; Pasko (n 35).

[44]   Kevin Strom, 'Research on the Impact of Technology on Policing Strategy in the 21st Century, Final Report' (Office of Justice Programs' National Criminal Justice Reference Service, May 2016) <https://www.ojp.gov/pdffiles1/nij/grants/251140.pdf> accessed 7 April 2022.

across Europe.[45] However, it was not long before criticisms and shortcomings emerged – especially in relation to the experience of applying predictive policing in the US – and police forces began to abandon the approach.[46]

4.   PARADISE LOST?

The term predictive policing suggests that the police can anticipate a crime and be there to stop it before it happens and/or apprehend the culprits right away. Prior to the development of predictive policing, police forces mapped the geographical location of different crime types to identify neighbourhoods with higher crime rates. Since the 1980s, criminological research has provided insight into how burglars operate – and such knowledge has helped police forces identify when and where future burglaries might occur.[47]

Predictive policing algorithms may be good at analysing a combination of factors to determine where crimes are more likely to happen and who is more likely to commit them. However, as data analysts are aware, predictions come nowhere near close to certainty, even with advanced technology. The accuracy of predictions depends upon the quality of the data input to the system. However, the data inputted to predictive policing systems is often inaccurate and prone to errors.[48]

In a previous project, *City Centre Crime*, which investigated crime hotspots in Greater Manchester (UK), the location for incidents of crime had to be corrected by the researcher in around 50% of cases. This is a time-consuming process that involves checking location data against other, more qualitative information about the incident.[49]

---

[45]   Bart Custers and Bas Vergouw, 'Promising Policing Technologies: Experiences, Obstacles and Police Needs regarding Law Enforcement Technologies' (2015) 31(4) Computer Law & Security Review.

[46]   Martin Degeling and Bettina Berendt, 'What is Wrong about Robocops as Consultants? A Technology-Centric Critique of Predictive Policing' (2018) 33 AI & Society.

[47]   Portland State University, Criminology and Criminal Justice Senior Capstone, 'Prevention of Residential Burglary: A Review of the Literature' (2010) Criminology and Criminal Justice Senior Capstone Project 3 <https://pdxscholar.library.pdx.edu/ccj_capstone/3> accessed 14 July 2022.

[48]   HV Jagadish, 'Big Data Analyses Depend on Starting with Clean Data Points' (TheConversation.com, 4 August 2015) <https://theconversation.com/big-data-analyses-depend-on-starting-with-clean-data-points-43687> accessed 7 April 2022.

[49]   Andrew B Wootton, Melissa Marselle and Caroline L Davey, 'City Centre Crime: Design thinking for safer city centres', Proceedings from the 8th European Academy of Design Conference 2009 – 1, 2 and 3 April 2009, The Robert Gordon University, Aberdeen, Scotland.

Even if the data were cleaned prior to input to reduce such errors, the algorithms are only determining correlations. All that the best algorithm can do is to say it is likely, but not certain, that a burglary will be committed in a particular location. Many intervening variables can prevent a burglary from taking place. Predictive policing tools simply provide police forces with probabilities based on statistical modelling, rather than certainty. A police department may add up these probabilities across all houses in a neighbourhood to estimate how likely it is that there will be a burglary. They can then place more officers in neighbourhoods with higher probabilities for crime on the basis that police presence may deter incidents. There does seem to be some evidence that targeted use of police resources does indeed reduce crime rates.[50] But are the data provided by predictive policing systems significantly better than the knowledge held by officers with many years of experience patrolling an area, or that gained from existing GIS-based incident recording systems? Either of these can allow police resources to be targeted to areas where one or more incidents (e.g., burglaries) have already taken place. However, this in itself is not always straightforward.

The placing of police officers in a particular location can have social and ethical consequences. The presence of police officers can result in more offences being detected – from traffic violations, through incivilities to illegal drug possession and dealing. Consequently, this may more strongly associate the neighbourhood and communities that live there with crime, which has the potential to result in more intense policing leading to particular communities being overly targeted.[51] In the US, the targeting of particular individuals and groups by the police has raised serious concerns about civil liberties.[52] Police in the US have a poor record in terms of

---

[50]   Stuart Wolpert, 'Predictive Policing Test Substantially Reduces Crime' (universityofcalifornia.edu, 7 October 2015). <https://www.universityofcalifornia.edu/news/predictive-policing-test-substantially-reduces-crime> accessed 7 April 2022.

[51]   Media Freedom & Information Access Clinic, 'Algorithmic Accountability: The Need for a New Approach to Transparency and Accountability When Government Functions Are Performed by Algorithms' [2022] Abrams Institute for Freedom of Expression, Yale Law School <https://law.yale.edu/sites/default/files/area/center/mfia/document/algorithmic_accountability_report.pdf> accessed 7 July 2022.

[52]   Lindsey Barret, 'Reasonably Suspicious Algorithms: Predictive Policing at the United States Border' (2018) 41 N.Y.U. Review of Law & Social Change 3. <https://socialchangenyu.com/review/reasonably-suspicious-algorithms-predictive-policing-at-the-united-states-border/> accessed 7 July 2022.

compliance with human rights,[53] and this has been exacerbated through the use of predictive policing to identify individuals likely to offend, rather than locations of risk.[54]

In Germany, where predictive policing has also been adopted, ethical and social issues were considered and addressed during their particular implementation of the approach.

5.   EXPLORATION OF PREDICTIVE POLICING ADOPTION IN GERMANY

Germany comprises 16 federal states, each with its own governing body and state police service. There are also three federal law enforcement agencies, one of which is the Federal Police.[55] Desk research, a survey and interviews were conducted as part of CCI to investigate use of predictive policing across Germany. Between 2014 and 2018, LEAs in six German states were working with predictive policing, having purchased a system from an external company or developed their own system in house. These were: Berlin, Bavaria, Baden-Württemberg, Hessen, Lower Saxony and North Rhine-Westphalia.[56] In addition, LEAs in a number of other German states were planning to introduce predictive policing over the next couple of years.[57]

German use of predictive policing focused initially on the identification of areas at higher risk of burglary. The main driver for this was the rising rate of domestic burglary in Germany as a whole and the low clearance

---

[53]   Rashida Richardson, Jason Schultz and Kate Crawford, 'Dirty Data, Bad Predictions: How Civil Rights Violations Impact Police Data, Predictive Policing Systems, and Justice' (2019) 94 NYU Law Review Online <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3333423> accessed 20 July 2022.

[54]   ibid.

[55]   Federal Ministry of the Interior and Community, 'The Federal Police' (bmi.bund.de, ND) <https://www.bmi.bund.de/EN/topics/security/federal-police/federal-police-node.html> accessed 5 April 2022.

[56]   Kai Seidensticker, Felix Bode and Florian Stoffel, 'Predictive Policing in Germany' [2018] 2 <http://nbn-resolving.de/urn:nbn:de:bsz:352-2-14sbvox1ik0z06> accessed 7 August 2022.

[57]   Maximillian Querbach, Marian Krom and Armando Jongejan, 'Review of State of the Art: Predictive Policing' (Cutting Crime Impact (CCI) Deliverable 2.3, Salford, UK, August 2020) <https://www.cuttingcrimeimpact.eu/resources/public-results/predictive-policing-/titulo/> accessed 6 April 2022; Alexander Gluba and Alexander Pett, 'Predictive Policing – ein (un)bekannter Ansatz – Definition, Ursprung und Rahmenbedingungen' in Martin HW Möllers and Robert C van Ooyen (eds), *Jahrbuch Öffentliche Sicherheit 2016/2017* (Nomos 2017).

rates for burglaries in the affected federal states.[58] It was recognised that domestic burglaries impact negatively on society, and result in financial and psychological harm to victims.[59] Due to intensive media attention, politicians and senior police officers were under significant public pressure to address the problem and allocate resources to burglary prevention.[60]

While other European countries, such as the UK and the Netherlands, were keeping burglary rates down through better design and security of residential areas, such approaches were less well established in Germany. In addition, burglaries were largely attributed to 'professional burglars' – career criminals that were entering Germany via the Netherlands.[61]

In October 2016, the interior ministers of the Netherlands, Belgium, Germany and the federal states of North Rhine-Westphalia, Rhineland-Palatinate and Lower Saxony signed the *Aachen Declaration*. This document recorded their agreement to strengthen cross-border cooperation in combating property crime. A variety of steps were taken to prevent burglary, one of which was the implementation of predictive policing.[62]

The use of algorithms to identify potential risk areas was perceived as an innovative approach to addressing public concerns about burglary and improving traditional policing methods.[63] With Germany somewhat

---

[58] Bundesministerium des Innern, 'Polizeiliche Kriminalstatistik 2015' (May 2016) 3 <https://www.bmi.bund.de/SharedDocs/downloads/DE/publikationen/themen/sicherheit/pks-2015.html> accessed 20 July 2022.

[59] Gina Rosa Wollinger and others, 'Wohnungseinbruch – Tat und Folgen – Ergebnisse einer Betroffenenbefragung in fünf Großstädten' (KFN-Forschungsberichte 124 Hannover 2014).

[60] Querbach and others (n 57).

[61] Gina Rosa Wollinger and Nadine Jukschat, 'Reisende und zugereiste Täter des Wohnungseinbruchs. Ergebnisse einer qualitativen Interviewstudie mit verurteilten Tätern' (Kriminologisches Forschungsinstitut Niedersachsen e.V. 2017) <https://kfn.de/wp-content/uploads/Forschungsberichte/FB_133.pdf> accessed 26 February 2023; Gina Rosa Wollinger and Nadine Jukschat, 'Foreign Burglars: Primary Results of an Interview Study with Arrested Offenders in Germany' (2017) 6 International Journal of Criminology and Sociology; Gina Rosa Wollinger and others, 'Offender Organization and Criminal Investigations with regard to Organised Residential Burglary Law Enforcement: Results of an International Expert Survey' (Kriminologisches Forschungsinstitut Niedersachsen e.V. (KFN) 2018) <https://kfn.de/wp-content/uploads/Forschungsberichte/FB_147%20en.pdf> accessed 3 August 2022.

[62] Landesregierung Nordrhein-Westfalen, 'Aachener Erklärung zur besseren Bekämpfung der grenzüberschreitenden Eigentumskriminalität' (31 October 2016) <https://www.land.nrw/pressemitteilung/aachener-erklaerung-zur-besseren-bekaempfung-der-grenzueberschreitenden> accessed 7 August 2022; Querbach and others (n 57).

[63] Querbach and others (n 57) 13.

lagging behind other European countries in terms of digitalisation, predictive policing may also have been seen as a welcome opportunity for the country to modernise.

Since 2014 and 2015 respectively, the states of Bavaria and Baden-Württemberg have been using a predictive policing system called *Precobs*. This system predicts domestic burglaries based on the near-repeat approach. The near-repeat phenomenon suggests that when a crime occurs in a specific location, the area surrounding that location may experience an increased risk of a similar crime occurring for a distinct period of time.[64] The system was developed by the institute for pattern-based forecasting technology in Oberhausen, Germany.[65] Precobs was tested in several cities and areas in Bavaria, before being adopted by the police.[66] The implementation of Precobs in Baden-Württemberg was evaluated by the Max Planck Institute for Foreign and International Criminal Law. However, the results proved inconsistent due to the problem of being able to attribute causal effects solely to the use of predictive policing – a common problem in evaluating policing practice.[67] In December 2018, the state of Saxony started a pilot project with the Precobs system.[68]

In 2015, the federal state of North Rhine-Westphalia developed a predictive policing tool, called SKALA, that brings together near-repeat and socio-economic theories about crime.[69] The in-house system predicts locations and times not only for domestic burglary, but also for commercial

---

[64]   Tasha J Youstin and others, 'Assessing the Generalizability of the Near Repeat Phenomenon' (2011) 38(10) Criminal Justice and Behavior; Jerry H Ratcliffe and George F Rengert, 'Near Repeat Patterns in Philadelphia Shootings' (2008) 21(1–2) Security Journal.

[65]   Tobias Knobloch, 'Vor die Lage kommen – Predictive Policing in Deutschland – Chancen und Gefahren datenanalytischer Prognosetechnik und Empfehlungen für den Einsatz in der Polizeiarbeit' (Gütersloh 2018) <https://www.bertelsmann-stiftung.de/fileadmin/files/BSt/Publikationen/GrauePublikationen/predictive.policing.pdf> accessed 26 February 2023.

[66]   Bayerisches Staatsministerium des Inneren, für Bau und Verkehr, 'Kooperationsvereinbarung Bayern – Baden-Württemberg zur Bekämpfung Wohnungseinbruchskriminalität' (2015) <https://www.stmi.bayern.de/med/pressemitteilungen/pressear-chiv/2015/248b/index.php> accessed 7 August 2022.

[67]   Dominik Gerstner, 'Predictive Policing in the Context of Residential Burglary: An Empirical Illustration on the basis of a Pilot Project in Baden-Württemberg, Germany' (2018) 3(2) European Journal for Security Research.

[68]   Querbach and others (n 57).

[69]   Simon Egbert, 'Predictive Policing in Deutschland: Grundlagen, Risiken, (mögliche) Zukunft' in Strafverteidigervereinigungen (ed.), *Räume der Unfreiheit: Texte und Ergebnisse des 42. Strafverteidigertages Münster* (Organisationsbüro der Strafverteidigervereinigungen 2018).

burglary and automobile-related offences (car theft and theft from cars). In its pilot phase, SKALA was tested in six cities in North Rhine-Westphalia, with the probable risk of the offences predicted for each district.[70] After being scientifically evaluated, SKALA was rolled out in 16 police departments within North Rhine-Westphalia.[71]

The State of Hessen developed a system in house, called KLB-operativ, which brings together crime-related data from police sources and socio-economic census-data.[72] Information about burglaries was initially provided via a web app, but was subsequently also made available via mobile phones. Information about burglaries over the previous ten days is displayed on an interactive map. The data are updated daily to enable police forces to deploy officers in a more targeted manner. KLB-operativ was piloted in the winter of 2015, when burglaries rates were particularly high.[73]

Police in the city-state of Berlin developed a system called KrimPro, which predicts crimes in 400×400m areas based on police data and freely accessible infrastructure and demographic data.[74] Working together with Microsoft, KrimPro was piloted in two districts in 2016, before being rolled out throughout the city of Berlin.[75]

---

[70]   Landeskriminalamt NRW, 'Abschlussbericht Projekt SKALA – Kurzfassung' (Düsseldorf 2018a) <https://lka.polizei.nrw/sites/default/files/2018-06/180208_Abschlussbericht_SKALA.pdf> accessed 26 February 2023; Landeskriminalamt NRW, 'Kooperative Evaluation des Projektes SKALA. Abschlussbericht der Zentralstelle Evaluation beim LKA NRW (ZEVA) und der Gesellschaft für innovative Sozialforschung und Sozialplanung e.V. Bremen (GISS)' (Düsseldorf 2018b) <https://lka.polizei.nrw/sites/default/files/2018-06/160131_Evaluationsbericht_SKALA_Kurzfassung.pdf> accessed 26 February 2023.

[71]   ibid; Seidensticker and others (n 56) 5; Querbach and others (n 57).

[72]   D Anbau, 'KLB-operativ – ein neues Instrument zur Bekämpfung des Wohnungseinbruchdiebstahls' in Bund Deutscher Kriminalbeamter (eds), *Hessen-Extra, Sonderausgabe zum Landesdelegiertentag* (2016); Egbert (n 69).

[73]   Querbach and others (n 57).

[74]   Alexander Dinger, 'Vorhersage-Software: So genau ist das Programm der Polizei' *Berliner Morgenpost* (Berlin 2019) <https://www.morgenpost.de/berlin/article216410297/Vorhersage-Software-So-genau-ist-das-Programm-der-Polizei.html> accessed 20 July 2022; Egbert (n 69); Michael Graupner, 'Kommissar Glaskugel: Polizei-Software sagt jetzt Einbrüche voraus' *BZ* (19 October 2017) <https://www.bz-berlin.de/archiv-artikel/polizei-software-sagt-jetzt-einbrueche-voraus> accessed 7 August 2022.

[75]   Seidensticker and others (n 56) 3.

5.1 Palantir

Hessen, North Rhine-Westphalia and Bavaria are currently using software from Palantir, a US-based big data analytics company. Other federal states (including Baden-Württemberg and Bremen) are also considering following suit. The software from Palantir should make police work easier, but its use is considered controversial.[76]

Since 2014, police in the federal state of Lower Saxony in Germany have tested, developed and deployed a predictive policing model.

5.2 Predictive Policing in Lower Saxony

The Landeskriminalamt (LKA) in Lower Saxony – a partner on *Cutting Crime Impact* – was one of the first in Germany to experiment with predictive policing.

In-house approach
Predictive software was initially jointly developed by the LKA in Lower Saxony with the IBM corporation and Karlsruhe Institute for Technology (KIT).[77] However, the LKA decided to complete development of the technology in house due to a number of issues, including:

- concerns about sharing with an external commercial partner confidential crime incident data and potentially sensitive crime predictions produced by the system, and
- a concern that, if developed by an external third party, the resulting system would essentially be a 'black box' to the LKA, in

---

[76] JA Allen, 'Controversial software from Palantir also on the rise in Germany: the police are in the lead "Gotham" a' (*then24*, 5 June 2022) <https://then24.com/2022/06/05/controversial-software-from-palantir-also-on-the-rise-in-germany-the-police-are-in-the-lead-gotham-a/> accessed 3 August 2022; Jannis Brühl, 'German Police Deploy Controversial Silicon Valley Surveillance Tool' (*WORLDCRUNCH*, 20 November 2018) <https://worldcrunch.com/tech-science/german-police-deploy-controversial-silicon-valley-surveillance-tool> accessed 3 August 2022.

[77] Alexander Gluba, 'Predictive Policing – eine Bestandsaufnahme' (2014) 6 Kriminalistik; Alexander Gluba, Stefan Heitmann and Nina Hermes, 'Reviktimisierungen bei Wohnungseinbrüchen – Eine empirische Untersuchung zur Bedeutung des Phänomens der (Near) Repeat Victimisation im Landkreis Harburg' (2015) 6 Kriminalistik; Alexander Gluba, 'Mehr offene Fragen als Antworten – Was vor einer Bewertung des Nutzens von Predictive Policing noch zu klären ist' (2016) 2 Die Polizei; Gluba and Pett (n 57) 436.

that they would not fully understand how the system generated predictions.[78]

Understanding and controlling the selection of data and information used to create crime predictions was prioritised by the LKA in Lower Saxony. By developing the system in house, the LKA has a comprehensive understanding of both the data being inputted into the system to generate predictions, and how results generated by the system are interpreted. Consequently, rather than purchasing an off-the-shelf predictive policing product, the LKA developed its own software system – PreMAP (Predictive Mobile Analytics for Police).

Mapping the risk of burglary

The LKA's PreMAP system uses geospatial data to identify locations that have a high probability of burglary. In addition, the system generates a map – sometimes called a 'crime radar' map – showing all relevant, police-recorded criminal offences from the previous four weeks.[79]

Using the near-repeat approach, PreMAP calculates a score that represents the probability of another burglary occurring within the next 72 hours in a radius of 400m of a previously recorded burglary incident. If the score exceeds a pre-set threshold, the system draws a 'risk area' (i.e., a red-lined area) on an interactive map. Specially trained officers have the ability to refine the prediction based on local intelligence by manually deactivating – or indeed activating – a risk area. The additional 'crime radar' map provides an overview of the last four weeks of police-recorded crime. Together with PreMAP's predictions, this is used to assess current crime trends.[80]

To feed the PreMAP system, the police in Lower Saxony collect detailed data about burglaries. All relevant prediction parameters are recorded by the police officers using the LKA's case management system, NIVADIS. This includes: incident location; type of property targeted; date and time of offence; offender *modus operandi*; and details of any stolen items. If no information is available regarding the specific time, the burglary is omitted from the prediction modelling. As is standard practice in Germany, when making the analysis, no personal data on the victim or perpetrator are

---

[78]   Cutting Crime Impact Practice sheet, 'Predictive Policing Tool: Can Algorithmic Prediction of Crime Really Facilitate the Work of the Police?' (CCI University of Salford, 2021) <https://www.cuttingcrimeimpact.eu/resources/practice-sheets/the-lka-predictive-policing-tool/?lang=en> accessed 8 April 2022.

[79]   ibid.

[80]   Querbach and others (n 57).

used.[81] The fact that the system was being used to forecast locations at risk of crime – not individual risk of offending – reduced some of the ethical issues associated with predictive policing. The idea is that PreMAP results inform the choice of areas patrolled by the police, with officers prioritising areas designated by the system as being at risk of burglary.[82] It is proposed that increased police presence in the area will both deter offenders and increase the likelihood of their apprehension.

PreMAP testing and implementation

PreMAP was tested initially in 2016 in six police departments in Lower Saxony: Salzgitter, Peine, Wolfenbüttel and the city of Wolfsburg, and subsequently Hanover and Osnabrück.[83] The pilot phase identified areas for improvement in communicating risk areas to police officers and ensuring deployment of officers. Nevertheless, it was generally felt that PreMAP would be accepted by police officers due to its simple design:

> The communication and implementation of PreMAP within the departments was satisfactory. The simple design of the program and its predicting approach ensured a high level of communicability and thus a high level of acceptance of the tool among police officers.[84]

Feedback from the piloting of PreMAP suggested that it generated additional benefits, including improving the supply of police-relevant data.

From an ethical perspective, the implementation of predictive policing using German in-house systems like PreMAP avoids several thorny issues relating to data protection and human rights. Knobloch sums this up as follows: 'Experience shows that … predictive policing, as currently practised in Germany, does not constitute an encroachment on civil rights.'[85] This is because the various systems in use in Germany, such as PreMAP, mainly process location-based information, not personal data.[86]

---

[81]   Seidensticker and others (n 56).
[82]   Querbach and others (n 57).
[83]   Landeskriminalamt, 'PreMAP – Predictive Policing (Vorausschauende Polizeiarbeit) in Niedersachsen' (lka.polizei-nds.de, ND) <https://www.lka.polizei-nds.de/startseite/kriminalitaet/forschung/premap/predictive-policing-in-niedersachsen-das-projekt-premap-114083.html> accessed 8 April 2022.
[84]   Querbach and others (n 57) 15.
[85]   Knobloch (n 65) 5 (translated from German).
[86]   Vanessa K Bauer, 'Predictive Policing in Germany: Opportunities and Challenges of Data-Analytical Forecasting Technology in order to Prevent Crime' (2019) Management Center Innsbruck <https://www.researchgate.net/publication/338411808_Predictive_Policing_in_Germany_Opportunities_and_chal

Within the CCI project, the LKA in Lower Saxony originally aimed to improve the technical use and effectiveness of PreMAP and predictive policing. In the event, the human-centred design approach adopted by CCI revealed different priorities.

6. CASE EXAMPLE: DEVELOPMENT OF THE CCI PREDICTIVE POLICING TOOL

6.1 Human-Centred Design within the CCI project

Led by the *Design Against Crime Solution Centre*, the CCI project adopted a human-centred design approach to the research and delivery of tools for partner law enforcement agencies (LEAs).[87] To this end, CCI focused on researching the human participants within the various design systems – in this case, LEAs and their stakeholder organisations.[88] For the CCI partners, this design research resulted in assumptions being challenged, initial problems being reframed and the tools eventually developed addressing fundamental issues that, in a number of cases, were previously hidden.

The CCI project delivery was characterised by three principles:

1) the inclusion of end-users (e.g., frontline practitioners) and a focus on the humans that would use the design solutions to be developed,
2) the collaboration and exchange of knowledge and experience between stakeholders and across different professional disciplines to enable problem framing and solution ideation (e.g., in *DesignLab* workshops), and
3) the early development of solution prototypes, and prototype testing with end-users to support solution validation, feasibility testing and design decision-making.[89]

The development and testing of design solutions is an iterative process – one in which solutions can be amended and improved in response to feedback from those who will ultimately use and benefit from them. For CCI,

---

lenges_of_data-analytical_forecasting_technology_in_order_to_prevent_crime> accessed 21 July 2022; Querbach and others (n 57).

[87] Cutting Crime Impact Practice Sheet (n 78).

[88] CCI, 'Toolkits' (cuttingcrimeimpact.eu, 2021) <https://www.cuttingcrim eimpact.eu/cci-toolkits/> accessed 4 August 2022.
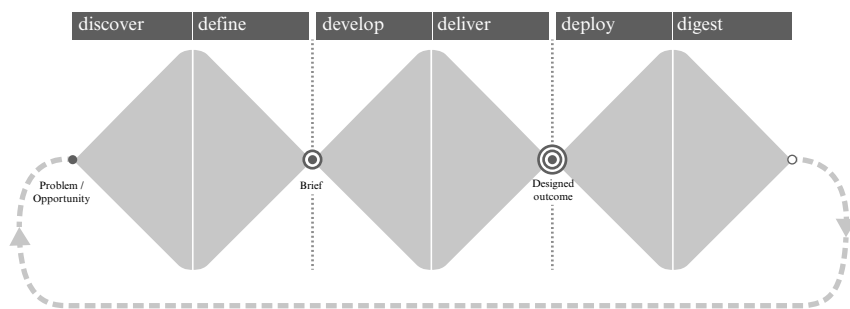
[89] CCI (n 8).

Figure 9.1   Triple Diamond model of the design process[90]

end-users were LEA practitioners and their delivery partners, while the design solutions were the tools developed during the project.[91]

In researching the predictive policing problem domain, LKA researchers worked closely with the different police officers that used PreMAP. This allowed them to gain insight into the problems end-users faced, the context in which they operated and the requirements the CCI tool needed to fulfil. In line with CCI's human-centred design approach, research, development and delivery of the tool followed the Triple Diamond model of design development.

6.2   The Triple Diamond Design Process Model

The Triple Diamond model, developed by Wootton and Davey in 2011, represents the design process as sequential phases of divergent and convergent thinking named *Discover*, *Define*, *Develop*, *Deliver*, *Deploy* and *Digest*, respectively (see Figure 9.1).[92]

During the *Discover* phase, divergent design research methods are used to support discovery and reframing of problems and deep understanding of the problem context.[93] This is followed by the *Define* phase, in which analysis methods and convergent thinking are used to generate insight and define the Design Brief. This leads to the *Develop* phase, in which ideation, concept generation and divergent thinking methods are employed to

---

[90]   Design Council, 'Designing Out Crime: A Designer's Guide' (Design Council: London 2011) <https://www.designcouncil.org.uk/sites/default/files/asset/document/designersGuide_digital_0_0.pdf> accessed 21 July 2022.
[91]   CCI (n 8).
[92]   Design Council (n 90).
[93]   ibid.

develop, prototype, test and resolve design options that meet the brief.[94] In the *Deliver* phase, the validated design option is refined, finalised and produced (i.e., made real) and preparations made for launch of the designed outcome. In the *Deploy* phase, the finished, delivered design is launched and deployed into its use context. This then kicks off the *Digest* phase, in which the designed outcome begins its life of being used, operated and maintained. Over time, potential problems and opportunities may be revealed, which themselves might feed into and be the catalyst for the Discover phase of a new design development process.[95]

6.3 Requirements Capture Research in the Discover Phase

The problem that the LKA in Lower Saxony ended up addressing emerged at the outset of the CCI research, in the *Discover* phase. In order to understand how the PreMAP system was being used in an operational policing context, LKA researchers identified a number of key end-user groups, including police officers, shift managers and data analysts. Observational research provided insights into the everyday activities of end-users, without interrupting or influencing their flow.[96] These insights also informed the ensuing interviews, allowing researchers to refine and target the questions they posed to stakeholders. During six months of requirements capture, the LKA undertook ethnographic (shadowing and observation), interview and focus group research.

Observational research conducted by the LKA revealed significant issues regarding the implementation of PreMAP.[97] The headline finding was that PreMAP was not in fact being used by frontline police officers at all. Predictive results were not being used by police officers to guide their patrol activities, and computer tablets provided for this purpose were not even being charged. Flat screen displays installed in police stations to present data resulting from PreMAP analysis were not being used for their intended purpose.[98] In short, investment in predictive policing

---

[94]   ibid.

[95]   ibid.

[96]   CCI, 'PIM Toolkit 1: LKA Tool' (cuttingcrimeimpact.eu, 2021) <https://www.cuttingcrimeimpact.eu/resources/public-results/predictive-policing-/pim-toolkit-1-lka-tool-/> accessed 7 August 2022.

[97]   Cutting Crime Impact Practice Sheet, 'Predictive Policing Tool: Can algorithmic prediction of crime really facilitate the work of police?' (www.cuttingcrimeimpact.eu, ND) <https://www.cuttingcrimeimpact.eu/resources/practice-sheets/the-lka-predictive-policing-tool/?lang=en> accessed 21 July 2022.

[98]   ibid.

systems and equipment was having little if any influence on frontline policing. Interviews and focus groups revealed police officers to be generally sceptical of the value of the data provided by PreMAP. In addition, reported technical issues regarding the speed and usability of the system were significant barriers to adoption by already busy police officers. For example, logging in to the tablet devices was perceived as overly slow and complicated.[99]

6.4   Problem Exploration and Reframing in the Define Phase

The problems identified in the Discover phase were presented by the LKA and creatively explored by the whole consortium during the *DesignLab* session held at the beginning of the *Define* phase of CCI tool development.[100] The DesignLab is a facilitated, collaborative ideation event, during which requirements capture findings are presented, research insights discussed, problems reframed and initial solution concepts developed.

Multiple stakeholders participated in the DesignLab, representing a diverse array of disciplinary backgrounds and professional experiences, and enabling creative thinking. Divided into four teams, the DesignLab concluded with each team presenting short 'pitches' for their two favourite concept solutions. Thus, the DesignLab generated eight more developed tool concepts, along with all the other ideas developed by the team on their journey to these 'favourites'. Finally, all the DesignLab participants were asked to vote on the different tool concepts presented.[101]

Following the DesignLab, the Design Against Crime Solution Centre analysed the resulting concepts and ideas produced by the participating teams. While not fully resolved tools, this material provided a pool of evidence-based, creative thinking demonstrating innovative interpretations of requirements directly linked to specific issues identified by the research. From this material, a number of potential '*solution directions*' for tool development were identified. These were discussed with the LKA and the design concept that led to the final tool was selected.[102]

---

[99]   ibid.

[100]   CCI, 'Report on Results of DesignLab 1' (cuttingcrimeimpact.eu, 2021) <https://www.cuttingcrimeimpact.eu/resources/public-results/predictive-policing-/report-on-results-of-designlab-1-/> accessed 7 August 2022.

[101]   ibid.

[102]   CCI, 'PATROL' (cuttingcrimeimpact.eu, 2021) <https://www.cuttingcrimeimpact.eu/toolkits/patrol/lka/> accessed 8 April 2022.

6.5   Solution Design and Prototyping in the Develop Phase

The design concept was developed, prototyped, tested and refined during the third (*Develop*) phase and finalised and produced during the fourth (*Deliver*) phase of CCI. Research with end-users during the *Develop* phase revealed that PreMAP data comprised only one of a number of types of information that should be provided more systematically in daily patrol briefings.

Consequently, a tool was designed to provide a standardised process for the internal communication, dissemination and use of both predictive data and general police data. The design aimed to also support the sharing of expertise by individual officers on a shift. Such a tool would ensure shift managers provided officers with essential information about risk areas and current crime trends, as well as important information from earlier shifts – which research showed was not always communicated between shift managers. In discussion with end-users, the LKA sought to optimise how information was shared with police officers, as this was found to vary widely, and often depended on the individual preferences of shift managers and analysts.[103]

6.6   The PATROL Tool

The final LKA tool was named PATROL, deriving its name from the German acronym ***P****olizeiliches **A**naly**s**etool zur **R**echerche und **O**rganisation von **L**ageinformationen im Einsatz- und Streifendienst.*

The PATROL tool provides a new process specifically designed to meet the needs of police officers and enable an intelligence-enhanced approach to patrolling. Using PATROL, valuable data, information and experience is communicated to police officers of the operations and patrol service quickly, and when needed.[104]

The tool comprises four main components:

1)   The Analyst Manual: a guide for analysts processing current crime and situation-related information. This supports the creation of daily situation reports that contain all the information relevant to colleagues in the operation and patrol service.
2)   A standardised briefing process: a new process of daily briefings for shift managers to more effectively communicate information on

---

[103]   ibid.
[104]   ibid.

current events and relevant developments in the area to the different shifts of police officers undertaking patrol duties.

3) The Briefing Manual: a guide for shift managers on the preparation and delivery of PATROL briefings to different shifts, including briefing templates for the various types of incidents and issues that are communicated.

4) Online information-sharing: PATROL enables exchange of information between patrolling officers through the Niedersachsen Messenger or NiMes-Channel – an existing secure online communication platform available to all police officers via their smartphones.[105]

The PATROL tool is being rolled out across Lower Saxony, and has been disseminated to police forces in Germany and across Europe. Options for evaluation of the impact of the PATROL tool – as well as all other tools developed by the CCI project – are currently being explored.

7.   DISCUSSION AND CONCLUSION

7.1   The Practical Politics of Predictive Policing

The LKA in Lower Saxony is far from alone in wanting to operationalise the analysis of crime incident data to forecast and prevent future offences.[106] From a human-centred design perspective, the problem is that technology-driven solutions, especially at the concept stage, are often promoted using what we term *could dos*. Potential use options are described in the form, 'With this technology, you could do X. You could do Y. You could do Z.' The problem arises in translating a technological *could do* into practical reality and developing a means of influencing the decisions of officers about where they choose to patrol between dealing with specific incidents.

Ambitious *could dos* easily transform into *hype*, especially when concerning new or as-yet-unimplemented technology. The hype surrounding predictive analytics has unsurprisingly attracted political interest and influenced decision-making around policing strategy. Nevertheless, the promise of applying predictive analytics to accurately forecast crime

---

[105]   ibid.
[106]   Simon Egbert and Matthias Leese, *Criminal Futures – Predictive Policing and Everyday Police Work*, 1st edn (Routledge 2021); Seidensticker and others (n 56).

remains tantalisingly out of reach.[107] Despite this, the technological *could do* of predictive policing remains a siren call to policymakers and technologists alike, with frontline police officers seldom involved in any meaningful way.

7.2 The Value of a Human-centred Approach

The human-centred design approach adopted by CCI revealed practical problems on the frontline of predictive policing.[108] In many ways, these reflected a lack of understanding of policing by technologists and software system developers. The inability to sell the practical benefits of predictive policing to frontline officers results in such systems being distrusted and at best ignored. It is problematic for busy frontline officers to be expected to plan their movements around areas they know well using data that have questionable accuracy.

Police officers have significant autonomy in how they discharge their duties and deliver their role. Predictive policing can be seen as an attempt to place an analytics system in charge of policing delivery in an area, with implementation reduced to a problem of *acceptance* by police officers. Technologists seem insensitive to the degree to which this undermines the self-perception and roles of individuals to whom their job is often a vocation. Rather than seeking to support and amplify the work of such intrinsically motivated individuals, predictive policing often appears to be aimed at controlling or even replacing it.

Human-centred design recognises that the promise of technology can only be realised through understanding, supporting and *delighting* the humans in a design system. As Steve Jobs famously remarked of Apple's ethos in this regard, 'It is technology married with the humanities that yields us the results that make our hearts sing.'[109] Successful solutions are not solely technology driven, but need to be tempered with an appreciation and understanding of the human context.

The main issues impacting practical implementation of predictive policing by the LKA in Lower Saxony were not technical. Problems were not related to analysis software or algorithms, but rather to the poor integration of the technological system (and its results) with the practical job of police patrolling, and the needs and preferences of those in this role.

---

[107] Jagadish (n 38).
[108] Querbach and others (n 57).
[109] Steve Jobs, iPad 2 launch, 2 March 2011.

Adopting a human-centred design approach allowed the LKA to reframe the problem from:

'How can we improve the predictive policing system and get police patrol officers to accept and follow its predictions?'

to:

'How might we better support the information needs of the police officers responsible for patrolling?'

This refocusing led to the insight that the systematic inclusion of many different types of relevant information was lacking from police officers' daily briefings. Information, intelligence and insights from fellow officers were not being shared across different teams and between shifts. This included – but importantly was not limited to – predictions generated by PreMAP, which was now viewed as one component of a more integrated, intelligence-informed model of police patrolling.

In developing their tool, the LKA shifted from a technology-centred focus on the PreMAP predictive policing system, to a human-centred focus on police patrolling and improving the quality, clarity and flow of information to the police officers responsible for this. End-user research during the *fuzzy front end* of the CCI tool development process enabled this problem reframing. Indeed, the results of this research with end-users would have been difficult to ignore.

At the outset of the CCI project, LKA researchers held a number of assumptions about the nature of the tool they would develop. Observational research was fundamental to confronting the LKA with the stark reality of end-users' operational context, challenging their assumptions and necessitating a reframing of the original problem. Researchers' observations supported development of more pertinent and fruitful questions for qualitative research with end-users. By understanding and clearly articulating end-user requirements and constraints, the CCI project was able to support the LKA through a human-centred design development process that resulted in a practical solution suited to the problem context.

As mentioned in section 2.1 above, design explores possible futures while producing tangible results. Importantly, such design futures are not limited to consideration of a technical capability – i.e., technology centred – but consider implications for the wider human experience of different stakeholders. This human-centred approach thereby allows consideration of the impact of proposed *solutions* on individual and social systems – and allows the optimisation of solutions for real-world contexts. Too often, proposals resulting from technology-driven design reflect only

technical requirements, with fundamental non-technical aspects (relating, for example, to human, social and political outcomes) minimised as of secondary importance. These are often only considered during implementation, after the design process is complete, in terms of narrowly conceptualised issues such as end-user *acceptance*. Unfortunately, it is often these more complex, poorly understood phenomena that are revealed as a *fatal flaw*, hindering successful implementation of such solutions and resulting in performance shortfall – especially in relation to early inflated expectations. However, it would seem that there is always another technology bus coming along to attract the attention of managers and decision-makers.

7.3 Innovation is about Good Design, not just New Technology

Public- and private-sector organisations alike are urged to embrace innovation in order to save time, reduce costs, solve problems or achieve competitive advantage over other (less innovative) organisations. According to the Collins English dictionary, innovation is 'the introduction of new ideas, methods, or things. An innovation is a new thing or a new method of doing something'.[110]

Too often, however, innovation is simply equated with technology – generally information technologies – in what David Rotman refers to as 'techno-optimism'.[111] This perspective on technology 'raged in the late 1990s and early 2000s and then dried up and turned to pessimism during the last decade – [but] is once again bubbling up.'[112]

Despite some pessimism about, for example, the real-world impact of social media, the unbounded hope – a kind of faith – that new technologies will solve all our problems remains strong. Until recently, this was certainly the case with big data and its application to predictive policing.

Of course, innovation should not solely be equated with technological development, but also understood as taking a variety of forms: new products, services, processes, systems of working or communication methods. Technology can be an enabler of any of these, but is not required for something to be considered innovative. In the case of the PATROL tool, the innovation was not technological, but rather involved:

---

[110]   Collins English Dictionary <https://www.collinsdictionary.com/dictionary/english/innovation> accessed 7 August 2022.

[111]   David Rotman, 'An Uber-Optimistic View of the Future' (*MIT Technology Review*, 27 October 2021) <https://www.technologyreview.com/2021/10/27/1037169/book-review-azeem-azhar/> accessed 8 April 2022.

[112]   ibid 1.

- A *new service* within the police provided to brief and inform police officers of priority issues and ongoing tasking during their shift.
- *New processes* for (i) managing the flow and organisation of information from PreMAP analysts, and (ii) managing the briefing of police officers.
- *New* use of the NiMes *system* for, (i) the provision of briefing information (including from crime analysts) to police officers during their shifts, and (ii) the updating and exchange of information between police officers themselves.

The development and application of PATROL by the LKA in Lower Saxony was therefore a significant innovation with many practical benefits for officers and the communities they serve. In addition, the PATROL tool and principles underpinning it have the potential to be exploited by LEAs in other federal states in Germany, and potentially across other European countries.

Finally, if and when predictive policing technology improves in the accuracy and usefulness of its predictive outputs, the human-centred design underpinnings of PATROL ensures that there is an effective process in place to more effectively operationalise these while meeting end-user needs.

ACKNOWLEDGEMENTS

NOTE

BIBLIOGRAPHY

Adams G, 'LAPD's Sci-Fi Solution to Real Crime' *Independent* (London, 11 January 2012) 32.

Allen JA, 'Controversial Software from Palantir also on the Rise in Germany: The Police Are in the Lead "Gotham" A' (*then24*, 5 June 2022) <https://then24.com/2022/06/05/controversial-software-from-palantir-also-on-the-rise-in-germany-the-police-are-in-the-lead-gotham-a/> accessed 3 August 2022.

Anbau D, 'KLB-operativ – ein neues Instrument zur Bekämpfung des Wohnungseinbruchdiebstahls' in Bund Deutscher Kriminalbeamter (eds), *Hessen-Extra, Sonderausgabe zum Landesdelegiertentag* (2016).

Barret L, 'Reasonably Suspicious Algorithms: Predictive Policing at the United States Border' (2018) 41, 3 N.Y.U. Review of Law & Social Change <https://socialchangenyu.com/review/reasonably-suspicious-algorithms-predictive-policing-at-the-united-states-border/> accessed 7 July 2022.

Bauer VK, 'Predictive Policing in Germany: Opportunities and Challenges of Data-Analytical Forecasting Technology in order to Prevent Crime' (2019) Management Center Innsbruck <https://www.researchgate.net/publication/338411808_Predictive_Policing_in_Germany_Opportunities_and_challenges_of_data-analytical_forecasting_technology_in_order_to_prevent_crime> accessed 21 July 2022.

Bayerisches Staatsministerium des Inneren, für Bau und Verkehr, 'Kooperationsvereinbarung Bayern – Baden-Württemberg zur Bekämpfung Wohnungseinbruchskriminalität' (2015) <https://www.stmi.bayern.de/med/pressemitteilungen/pressear-chiv/2015/248b/index.php> accessed 7 August 2022.

Bhuiyan J, 'LAPD Ended Predictive Policing Programs amid Public Outcry: A New Effort Shares Many of Their Flaws' *The Guardian* (8 November 2021) <https://www.theguardian.com/us-news/2021/nov/07/lapd-predictive-policing-surveillance-reform> accessed 2 August 2022.

Broeders D and others, 'Big Data and Security Policies: Towards a Framework for Regulating the Phases of Analytics and Use of Big Data' (2017) 33 Computer Law and Security Law Review.

Brühl J, 'German Police Deploy Controversial Silicon Valley Surveillance Tool' (*WORLDCRUNCH*, 20 November 2018) <https://worldcrunch.com/tech-science/german-police-deploy-controversial-silicon-valley-surveillance-tool> accessed 3 August 2022.

Buchanan R, 'Declaration by Design: Rhetoric, Argument, and Demonstration in Design Practice' in V Margolin (eds), *Design Discourse: History, Theory, Criticism* (The University of Chicago Press 1989).

Bundesministerium des Innern, 'Polizeiliche Kriminalstatistik 2015' (May 2016) <https://www.bmi.bund.de/SharedDocs/downloads/DE/publikationen/themen/sicherheit/pks-2015.html> accessed 20 July 2022.

CCI, 'Introduction to CCI' (cuttingcrimeimpact.eu, 2021) <https://www.cuttingcrimeimpact.eu/about/introduction-to-cci/> accessed 7 July 2022.

CCI, 'PATROL' (cuttingcrimeimpact.eu, 2021) <https://www.cuttingcrimeimpact.eu/toolkits/patrol/lka/> accessed 8 April 2022.

CCI, 'PIM Toolkit 1: LKA Tool' (cuttingcrimeimpact.eu, 2021) <https://www.cuttingcrimeimpact.eu/resources/public-results/predictive-policing-/pim-toolkit-1-lka-tool-/> accessed 7 August 2022.

CCI, 'Project Design' (cuttingcrimeimpact.eu, 2021) <https://www.cuttingcrimeim pact.eu/about/project-design/> accessed 4 August 2022.

CCI, 'Report on Results of DesignLab 1' (cuttingcrimeimpact.eu, 2021) <https:// www.cuttingcrimeimpact.eu/resources/public-results/predictive-policing-/ report-on-results-of-designlab-1-/> accessed 7 August 2022.

CCI, 'Toolkits' (cuttingcrimeimpact.eu, 2021) <https://www.cuttingcrimeimpact. eu/cci-toolkits/> accessed 4 August 2022.

Collins English Dictionary <https://www.collinsdictionary.com/dictionary/ english/innovation> accessed 7 August 2022.

Collins A, Joseph D and Bielaczyc K, 'Design Research: Theoretical and Methodological Issues' (2004) 13(1) The Journal of the Learning Sciences.

Costanzo P, D'Onofrio F. and Friedl J, 'Big Data and the Italian Legal Framework: Opportunities for Police Forces' in B Akhgar and others (eds), *Application of Big Data for National Security* (Oxford 2015).

Custers B and Vergouw B, 'Promising Policing Technologies: Experiences, Obstacles and Police Needs Regarding Law Enforcement Technologies' (2015) 31(4) Computer Law & Security Review.

Cutting Crime Impact Practice Sheet, 'Predictive Policing Tool: Can Algorithmic Prediction of Crime Really Facilitate the Work of Police?' (www.cuttingcrimeim pact.eu, 2021) <https://www.cuttingcrimeimpact.eu/resources/practice-sheets/ the-lka-predictive-policing-tool/?lang=en> accessed 21 July 2022.

Davey CL and Wootton AB, *Design against Crime: A Human-Centred Approach to Designing for Safety and Security* (Routledge 2017).

Davey CL and Wootton AB, 'Transformation Design – Creating Security & Wellbeing' in W Jonas, K Von Anshelm and S Zerwas (eds), *Transformation Design* (BIRD 2016).

Dedehayir O and Steinert M, 'The Hype Cycle Model: A Review and Future Directions' (2016) 108 Technological Forecasting and Social Change.

Degeling M. and Berendt B, 'What is Wrong about Robocops as Consultants? A Technology-Centric Critique of Predictive Policing' (2018) 33 AI & Society.

Design Council, 'Designing Out Crime: A Designer's Guide' (Design Council: London 2011) <https://www.designcouncil.org.uk/sites/default/files/asset/docu ment/designersGuide_digital_0_0.pdf> accessed 21 July 2022.

Dinger A, 'Vorhersage-Software: So genau ist das Programm der Polizei' Berliner Morgenpost (Berlin, 2019) <https://www.morgenpost.de/berlin/article2164102 97/Vorhersage-Software-So-genau-ist-das-Programm-der-Polizei.html> accessed 20 July 2022.

Egbert S and Leese M, *Criminal Futures: Predictive Policing and Everyday Police Work*, 1st edn (Routledge 2021).

Egbert S, 'Predictive Policing in Deutschland. Grundlagen, Risiken, (mögliche) Zukunft' in Strafverteidigervereinigungen (ed.), Räume der Unfreiheit. Texte und Ergebnisse des 42. Strafverteidigertages Münster (Organisationsbüro der Strafverteidigervereinigungen 2018).

Egge J, 'Experimenting with Future-Oriented Analysis at Crime Hot Spots in Minneapolis' (2011) 2(4) Geography & Public Safety <https://www.ojp.gov/ ncjrs/virtual-library/abstracts/experimenting-future-oriented-analysis-crime-hot-spots-minneapolis> accessed 7 April 2022.

Federal Ministry of the Interior and Community, 'The Federal Police' (bmi.bund. de, ND) <https://www.bmi.bund.de/EN/topics/security/federal-police/federal-police-node.html> accessed 5 April 2022.

Ferguson AG, *The Rise of Big Data Policing* (New York University Press 2017).

García S, Ramírez-Gallego S, Luengo J, Benítez JM and Herrera F, 'Big Data Preprocessing: Methods and Prospects' (2016) 1(9) Big Data Analytics.

Gerstner G, 'Predictive Policing in the Context of Residential Burglary: An Empirical Illustration on the basis of a Pilot Project in Baden-Württemberg, Germany' (2018) 3(2) European Journal for Security Research 2.

Gilbertson A, 'Data-Informed Predictive Policing Was Heralded As Less Biased. Is It?' *The Markup* (NY, 20 August 2020) <https://themarkup.org/the-break down/2020/08/20/does-predictive-police-technology-contribute-to-bias> accessed 2 August 2022.

Gluba A, 'Predictive Policing – eine Bestandsaufnahme' (2014) 6 Kriminalistik.

Gluba A, Heitmann S and Hermes N, 'Reviktimisierungen bei Wohnungseinbrüchen – Eine empirische Untersuchung zur Bedeutung des Phänomens der (Near) Repeat Victimisation im Landkreis Harburg' (2015) 6 Kriminalistik.

Gluba A, 'Mehr offene Fragen als Antworten – Was vor einer Bewertung des Nutzens von Predictive Policing noch zu klären ist' (2016) 2 Die Polizei.

Gluba A and Pett A, 'Predictive Policing – ein (un)bekannter Ansatz – Definition, Ursprung und Rahmenbedingungen' in MHW Möllers and RC van Ooyen (eds), *Jahrbuch Öffentliche Sicherheit 2016/2017* (Nomos 2017).

Graupner M, 'Kommissar Glaskugel. Polizei-Software sagt jetzt Einbrüche voraus' *BZ* (Berlin, 19 October 2017) <https://www.bz-berlin.de/archiv-artikel/ polizei-software-sagt-jetzt-einbrueche-voraus> accessed 7 August 2022.

Gstrein OJ, Bunnik A and Zwitter A, 'Ethical, Legal and Social Challenges of Predictive Policing' (2019) 3 Católica Law Review.

IBM, 'Big Data Analytics' (IBM.com, ND) <https://www.ibm.com/analytics/ big-data-analytics> accessed 6 April 2022.

Jagadish HV, 'Big Data Analyses Depend on Starting with Clean Data Points' (TheConversation.com, 4 August 2015) <https://theconversation.com/big-data-analyses-depend-on-starting-with-clean-data-points-43687> accessed 7 April 2022.

Jagadish HV, 'The Promise and Perils of Predictive Policing based on Big Data' (TheConversation.com, 16 November 2016) <https://theconversation.com/the-promise-and-perils-of-predictive-policing-based-on-big-data-48366> accessed 6 April 2022.

Kentonline, 'Predpol Software which Targets Crime Down to Small Zones Has Slashed North Kent Crime by 6%' (Kent, 2013) <www.kentonline.co.uk/kent/ news/crime-innorth-kent-slashed-4672> accessed 18 July 2022.

Knobloch T, 'Vor die Lage kommen – Predictive Policing in Deutschland – Chancen und Gefahren datenanalytischer Prognosetechnik und Empfehlungen für den Einsatz in der Polizeiarbeit' (Gütersloh 2018) <https://www.bertels mann-stiftung.de/fileadmin/files/BSt/Publikationen/GrauePublikationen/predic tive.policing.pdf> accessed 26 February 2023.

Krippendorff K, Design Discourse: A Way to Redesign Design. Keynote Address to the Society for Science of Design Studies, 6 December 1998. Available from Scholarly Commons, University of Pennsylvania.

Landeskriminalamt, 'PreMAP – Predictive Policing (Vorausschauende Polizeiarbeit) in Niedersachsen' (lka.polizei-nds.de, ND) <https:// www.lka.polizei-nds.de/startseite/kriminalitaet/forschung/premap/

predictive-policing-in-niedersachsen-das-projekt-premap-114083.html> accessed 8 April 2022.

Landeskriminalamt NRW, 'Abschlussbericht Projekt SKALA – Kurzfassung' (Düsseldorf 2018a) <https://lka.polizei.nrw/sites/default/files/2018-06/180208_Abschlussbericht_SKALA.pdf> accessed 26 February 2023.

Landeskriminalamt NRW, 'Kooperative Evaluation des Projektes SKALA. Abschlussbericht der Zentralstelle Evaluation beim LKA NRW (ZEVA) und der Gesellschaft für innovative Sozialforschung und Sozialplanung e.V. Bremen (GISS)' (Düsseldorf 2018b) <https://lka.polizei.nrw/sites/default/files/2018-06/160131_Evaluationsbericht_SKALA_Kurzfassung.pdf> accessed 26 February 2023.

Landesregierung Nordrhein-Westfalen, 'Aachener Erklärung zur besseren Bekämpfung der grenzüberschreitenden Eigentumskriminalität' (31 October 2016) <https://www.land.nrw/pressemitteilung/aachener-erklaerung-zur-besseren-bekaempfung-der-grenzueberschreitenden> accessed 7 August 2022.

Laney D, '3D Data Management: Controlling Data Volume, Velocity and Variety' Gartner, 2 February 2001 <https://studylib.net/doc/8647594/3d-data-management--controlling-data-volume--velocity--an…> accessed 14 July 2022.

Madrigal AC, 'The Future of Crime-Fighting or the Future of Racial Profiling? Inside the Effects of Predictive Policing' (HuffPost.com, 28 March 2016) <https://www.huffpost.com/entry/predictive-policing-video_n_56f898c9e4b0a372181a42ef> accessed 5 April 2022.

Mallappallil M, Sabu J, Gruessner A and Salifu M, 'A Review of Big Data and Medical Research' (2020) 8 SAGE open Med 1.

McAfee A and Brynjolfsson E, 'Big Data: The Management Revolution' (Harvard Business Review, October 2012) <https://hbr.org/2012/10/big-data-the-management-revolution> accessed 6 April 2022.

Media Freedom & Information Access Clinic, 'Algorithmic Accountability: The Need for a New Approach to Transparency and Accountability When Government Functions Are Performed by Algorithms' (2022) Abrams Institute for Freedom of Expression, Yale Law School <https://law.yale.edu/sites/default/files/area/center/mfia/document/algorithmic_accountability_report.pdf> accessed 7 July 2022.

Meijer A and Wessels M, 'Predictive Policing: Review of Benefits and Drawbacks' (2019) 42 International Journal of Public Administration.

Nilsson P, 'First UK Police Force to Try Predictive Policing Ends Contract' *Financial Times* (London, 26 November 2018).

Pasko JM, 'Time Magazine Names Santa Cruz Police Program to Predict Crime One of the Year's Top Inventions' *The Mercury News* (Santa Cruz, 23 November 2011) <https://www.mercurynews.com/2011/11/23/time-magazine-names-santa-cruz-police-program-to-predict-crime-one-of-the-years-top-inventions/> accessed 6 April 2022.

Pearsall B, 'Predictive Policing: The Future of Law Enforcement?' (2010) 266 NIJ Journal 16 <https://www.ojp.gov/pdffiles1/nij/230414.pdf> accessed 3 August 2022.

Portland State University, Criminology and Criminal Justice Senior Capstone, 'Prevention of Residential Burglary: A Review of the Literature' (2010) Criminology and Criminal Justice Senior Capstone Project 3 <https://pdxscholar.library.pdx.edu/ccj_capstone/3> accessed 14 July 2022.

PredPol, 'Predictive Policing: The Predictive Policing Company' (2015) <www.predpol.com> accessed 18 July 2022.

Querbach M, Krom M and Jongejan A, 'Review of State of the Art: Predictive Policing' (Cutting Crime Impact (CCI) Deliverable 2.3, Salford, UK, August 2020) <https://www.cuttingcrimeimpact.eu/resources/public-results/predictive-policing-/titulo/> accessed 6 April 2022.

Ratcliffe JH and Rengert GF, 'Near Repeat Patterns in Philadelphia Shootings' (2008) 21(1–2) Security Journal.

Richardson R, Schultz J and Crawford K, 'Dirty Data, Bad Predictions: How Civil Rights Violations Impact Police Data, Predictive Policing Systems, and Justice' (2019) 94 NYU Law Review Online <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3333423> accessed 20 July 2022.

Rotman D, 'An Uber-Optimistic View of the Future' (*MIT Technology Review*, 27 October 2021) <https://www.technologyreview.com/2021/10/27/1037169/book-review-azeem-azhar/> accessed 8 April 2022.

Rouse WB, *Design for Success: A Human-Centered Approach to Designing Successful Products and Systems* (Wiley 1991).

Seidensticker K, Bode F and Stoffel F, 'Predictive Policing in Germany' [2018] 2 <http://nbn-resolving.de/urn:nbn:de:bsz:352-2-14sbvox1ik0z06> accessed 7 August 2022.

Strom K, 'Research on the Impact of Technology on Policing Strategy in the 21st Century, Final Report' (Office of Justice Programs' National Criminal Justice Reference Service, May 2016) <https://www.ojp.gov/pdffiles1/nij/grants/251140.pdf> accessed 7 April 2022.

Uchida CD, 'Predictive Policing' in Gerban Bruinsma and David Weisburd (eds), *Encyclopedia of Criminology and Criminal Justice* (Springer 2014).

van Brakel R, 'Pre-Emptive Big Data Surveillance and Its (Dis)Empowering Consequences: The Case of Predictive Policing' in Bart van der Sloot and others (eds), *Exploring the Boundaries of Big Data* (Amsterdam University Press 2016).

Winston A, 'Predictive Policing Is "Wave of the Future," NY commissioner says' (revealnews.org, 31 July 2015) <https://revealnews.org/article/predictive-policing-is-wave-of-the-future-ny-commissioner-says/> accessed 7 April 2022.

Wollinger GR and others, 'Wohnungseinbruch – Tat und Folgen – Ergebnisse einer Betroffenenbefragung in fünf Großstädten' (KFN-Forschungsberichte 124 Hannover 2014).

Wollinger GR and Jukschat N, 'Reisende und zugereiste Täter des Wohnungseinbruchs. Ergebnisse einer qualitativen Interviewstudie mit verurteilten Tätern' (Kriminologisches Forschungsinstitut Niedersachsen e.V. 2017) <https://kfn.de/wp-content/uploads/Forschungsberichte/FB_133.pdf> accessed 26 February 2023.

Wollinger GR and Jukschat N, 'Foreign Burglars: Primary Results of an Interview Study with Arrested Offenders in Germany' (2017) 6 International Journal of Criminology and Sociology.

Wollinger GR and others, 'Offender Organization and Criminal Investigations with regard to Organised Residential Burglary Law Enforcement: Results of an International Expert Survey' (Kriminologisches Forschungsinstitut Niedersachsen e.V. 2018) <https://kfn.de/wp-content/uploads/Forschungsberichte/FB_147%20en.pdf> accessed 3 August 2022.

Wolpert S, 'Predictive policing test substantially reduces crime' (universityof

california.edu, 7 October 2015) <https://www.universityofcalifornia.edu/news/predictive-policing-test-substantially-reduces-crime> accessed 7 April 2022.

Wootton AB, Marselle M and Davey CL, 'City Centre Crime: Design thinking for safer city centres', Proceedings from the 8th European Academy of Design Conference 2009 – 1, 2 and 3 April 2009, The Robert Gordon University, Aberdeen, Scotland.

Youstin TJ and others, 'Assessing the Generalizability of the Near Repeat Phenomenon' (2011) 38(10) Criminal Justice and Behavior.