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THE PROBLEM WITH CRIME PROBLEM-SOLVING: TOWARDS A SECOND GENERATION POP?

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In his 2018 Stockholm prize winner lecture, Goldstein highlighted the need for problem-oriented policing (POP) to be not only effective but also fair. Contributing to the development of POP, this study examines how a wider perspective on problem-solving generally, and scoping in particular, can be adopted to address some of the growing challenges in 21st century policing. We demonstrate that the concept of 'problem' was too narrowly defined and that, as a result, many problem-solving models found in criminology are ill-structured to minimize the negative side-effects of interventions and deliver broader benefits. Problem-solving concepts and models are compared across disciplines and recommendations are made to improve POP, drawing on examples in architecture, conservation science, industrial ecology and ethics.

Key Words: problem-solving, problem-scoping, problem-oriented policing, crime, evaluation

Introduction

In this article, we revisit the problem-oriented policing (POP) literature and argue that the current conception of crime problem, akin to an obstacle, has overshadowed the goals that are threatened by crime. We draw on a cross-disciplinary perspective to show that not only is this narrow conception of the term at odds with the problem-solving literature in other fields but also that it can result in inefficient, counterproductive or even harmful police practice.

POP and problem-solving

Inspired by operations research, POP was proposed in the late 1970s as a new paradigm for tackling crime (Wilkins, 1997). To mitigate against potential overreliance on idiosyncratic and bureaucratic objectives—the 'means over ends' syndrome—Goldstein (1979) recommended police services to direct their activities towards a *single* objective:

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reduction of crime and related issues. More specifically, he advocated to 'change the conditions that give rise to recurring crime problems and […] not simply rely on responding to incidents as they occur or forestalling them through preventive patrols' (Clarke and Eck 2014). Since then, POP has found many proponents amongst crime reduction practitioners, and the problem-solving approach has diffused beyond the realm of policing (Sidebottom and Tilley 2011; Tilley and Laycock 2014). POP has further made connections with the emerging approach known as crime science (Laycock 2005), which applies concepts, methods and knowledge from a wide range of scientific disciplines to the processes of reducing and investigating crime. The connections of particular relevance, which are currently more potential than actual, include the use of novel data collection methods, advanced analytic, simulation and evaluative techniques, a richer and more theory/mechanism-oriented array of causal explanations for crime and an equally greater scope of intervention techniques based on everything from applied neuroscience to the construction of resilient buildings.

The achievements of POP were recently celebrated by the criminology community with the award of the Stockholm Prize (Goldstein 2018b). However, also noteworthy is the still limited take-up of the approach, despite several decades of advocacy and support for practitioners and managers, e.g., from the UK Home Office and the Center for Problem-Oriented Policing. Factors thought to underlie the failure of POP to embed within police practice have included a police subculture favouring enforcement and limited analysis (Tilley and Scott 2012); a rank structure hostile to bottom-up initiatives, tokenistic management, obsession with narrow quantitative metrics and an inappropriate service-based model rather than a risk-based regulatory one (Sparrow 2016); inadequacy in managing 'practice knowledge' (Ekblom 2011a), particularly the failure to engage with complexity; the 'wicked' nature of many crime problems (Rittel and Webber 1973), i.e., those which are hard to solve because of incomplete, contradictory and changing requirements or, alternatively put, problems which are complex, dynamic and networked (Dorst 2015) and the fact that moving away from the legal 'purity' of enforcement leads the police into sometimes difficult relationships with other agencies and stakeholders and engagement with politicized issues (Ekblom 1986; 2011a; Wilson and Kelling 1989). In this paper, we aim to explore a further perspective: whether the current conceptions of problems and problem-solving themselves are adequate to support POP and whether tighter links via crime science to the wider perspectives of design, engineering and risk management might boost the performance of POP in ways that beneficially interact with the constraints on uptake just identified.

In POP, a problem is defined as 'a cluster of similar, related, or recurring incidents rather than a single incident; a substantive community concern; or a unit of police business' (Goldstein 1990: 66). Analogies have been drawn between crime science and medical science (Tilley *et al.* 2002; Laycock 2005), considering first that crime is conceptually equivalent to a disease and second that law enforcement agencies have a role in both treatment and prevention. As Sherman (1992: 221) puts it, 'police can use their contacts with victims, places, and offenders to attack causal chains as well as to treat the specific cases'.

Calling for practitioners' efforts to focus on crime reduction rather than organizational issues and other secondary managerial objectives constituted major progress.

Another milestone was reached shortly after with the creation of a dedicated five-step process similar to the IDEAL problem-solving model of Bransford and Stein (1993):

> (1) collection of data about the nature and dimensions of the problem, (2) an analysis of the situational conditions that permit or facilitate the commission of the crimes in question, (3) a systematic study of possible means of blocking opportunities for these particular crimes, (4) the implementation of the most promising, feasible, and economic measures, and (5) a (constant) monitoring of results and dissemination of experience (Gladstone 1980).

Gladstone's framework catalysed the development of tools for a problem-oriented approach to crime reduction and was later supplanted by a four-stage model called the Scanning-Analysis-Response-Assessment model or SARA (Figure 1) created by Eck and Spelman (1987) with input from Goldstein.

Over the years, modifications were made to this model that contributed to the description now offered by the Center for Problem-Oriented Policing (2017):

> *Scanning*: Identifying recurring problems of concern to the public and the police. Identifying the consequences of the problem for the community and the police. Prioritizing those problems. Developing broad goals. Confirming that the problems exist. Determining how frequently the problem occurs and how long it has been taking place. Selecting problems for closer examination.
> *Analysis*: Identifying and understanding the events and conditions that precede and accompany the problem. Identifying relevant data to be collected. Researching what is known about the problem type. Taking inventory of how the problem is currently addressed and the strengths and limitations of the current response. Narrowing the scope of the problem as specifically as possible. Identifying a variety of resources that may be of assistance in developing a deeper understanding of the problem. Developing a working hypothesis about why the problem is occurring.
> *Response*: Brainstorming for new interventions. Searching for what other communities with similar problems have done. Choosing among the alternative interventions. Outlining a response plan and identifying responsible parties. Stating the specific objectives for the response plan. Carrying out the planned activities.
> *Assessment*: Determining whether the plan was implemented (a process evaluation). Collecting pre- and post-response qualitative and quantitative data. Determining whether broad goals and specific objectives were attained. Identifying any new strategies needed to augment the original plan. Conducting ongoing assessment to ensure continued effectiveness.

SARA is not the only problem-solving model designed specifically to serve crime reduction; nevertheless, it is among the most popular among crime analysts (Sidebottom and Tilley 2011). Others include PROblem, Cause, Tactic or Treatment, Output, and

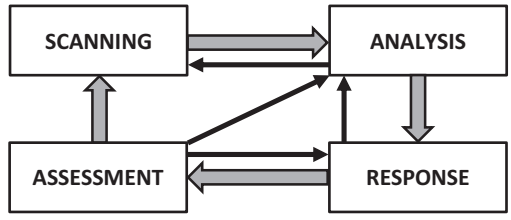

Fig. 1 Structure of the SARA problem-solving model.

Result (PROCTOR) (Read and Tilley 2000), Clients, Acquire information, Partners, Response, Assessment (CAPRA) (Deukmedjian and Lint 2007; McGarry 2010), Intelligence, Intervention, Implementation, Involvement, Impact (5Is) (Ekblom 2011a) and Scan, Prioritise, Analysis, Task, Intervene, Assess, Learn (SPATIAL) (Burton and McGregor 2018).

As with other action research models, simplicity, for want of a better word, was probably a key factor in the diffusion of SARA. Another element is the strong emphasis the model places on Analysis and Assessment. While any POP process would involve problem identification and intervention, just how effective the response is depends on how well it is matched to the problem and context of interest—a quality developed and evaluated through the Analysis and Assessment stages, respectively.

Despite their differences, all these models reflect two common understandings amongst their users. First, they are all crime-centric: as explained above, the problem is the recurrent manifestation of crime events. Second, they are all aimed at removing, or at least reducing, it.

Notwithstanding the challenges in implementing Goldstein's ideas (Tilley and Scott 2012), refocusing the role of police practitioners towards crime reduction and away from simply answering individual calls for service or catching criminals seems sensible. But any suggestion that their work should be driven by other goals would likely be considered by POP enthusiasts a dilution of Goldstein's vision. Similarly, proposals to revise the concept of problem, and to modify problem-solving models, would probably not receive much support in policing circles today. However, we here seek to challenge this status quo.

In this article, drawing on a cross-disciplinary perspective, we argue that problem-solving models such as SARA are too narrowly conceived, offsetting the advantages of the sharper focus they confer and that they should be transformed to explain how interventions must be designed and implemented to satisfy the wider needs of a broad range of stakeholders and to address the multidimensional and complex nature of most problems. Many of our arguments stem from the observation that Goldstein's heuristic conception of the term 'problem' was incomplete (possibly because of the desire to refocus policing activities on crime reduction) and does not match those used in other disciplines, especially artificial intelligence, design and engineering. In making those claims, we do not seek to equate these disciplines with simplistic, one-dimensional solutions of the kind that may have been put forward in the past but in their current guise that fully engages with the complex and challenging nature of social problems. Nor do we aim to supplant the problem-oriented approach but rather to improve it.

The article continues as follows. First, we discuss what we see as the narrowness of police problem-solving and problem orientation and the limits this imposes on crime reduction performance. Next, we draw on our own practical/academic experiences in identifying and addressing problems in diverse fields of practice and research. Then, we attempt to draw lessons for POP in terms of a clearer definition of the concept of problem and improvements in how POP actually formulates its problems and in the wider process model.

Police problem-solving—scope for revision?

A couple of decades ago, Ekblom and Pease (1995; see also Ekblom 2011a) recommended that crime prevention practitioners also examine wider issues such as 'Were there unintended effects of the action (exacerbation of fear, […], stigmatization of areas or potential offenders)?' Other authors have gone further, indicating the importance of addressing and/or evaluating the economic impacts (Painter and Farrington 2001; Welsh *et al.* 2001; Roman and Farrell 2002; Anderson *et al.* 2009; Johnson *et al.* 2015), social impacts (Clarke 1997: 38; Felson and Clarke 1997; Norrie 2002: 120) and iatrogenic impacts (Marx 1995; Dishion *et al.* 1999; Weiss et al. 2005; Sherman 2007; Cecile and Born 2009; Gatti *et al.* 2009; Welsh and Rocque 2014; Braga 2016) of crime reduction measures. Borrion *et al.* (2014) discussed the impact of security measures on safety and services. Goldstein himself, in his Stockholm Award acceptance address (2018b), raised the issue of fairness in POP responses; and Sparrow (2016) noted that focus on ends, if not matched by controls on means, can lead to behaviours that are unwise, risky or illegal.

Despite the calls for widening the scope of evaluation studies, the great majority of them are focussed on the effect of interventions on crime (and usually crime rates). Reviewing over 200 problem-solving initiatives, Read and Tilley reiterated that suitable interventions should not be merely understood as effective ones:

> Problem-solving is demonstrably successful where the result attributable to the interventions introduced comprises an elimination or reduction of a problem, or the pre-emption of a problem that could otherwise reasonably have been expected, *without unacceptable identifiable side-effects* (Read and Tilley 2000: 30).

By implication, we can conclude that the problems tackled by practitioners should not be defined in terms of crime or crime reduction alone. Indeed, the adequacy of interventions greatly depends upon the ways analysts frame the problems to solve in the first place.

As an example, the system dynamics model in Figure 2 illustrates three different ways of formulating the same fly-tipping problem. It shows the relationships (arrows) between a specific intervention (the introduction of a closed-circuit television [CCTV] camera in a residential area), the likelihood of specific incidents (illegal waste disposal) and four individual and societal goals related to environmental, aesthetic, financial and privacy impacts. Following Goldstein's original definition of *problem*, the analytical focus is on the hypothesized negative association between two types of events: the intervention and the incidence of fly-tipping events in this case (see circles in Figure 2a). With such a narrow focus, evaluating an intervention primarily equates to assessing its narrowly conceived effectiveness: did the introduction of the CCTV camera reduce fly-tipping rates? A richer picture starts to appear, however, when considering the goals that are in turn affected by crime (see black pentagons in Figure 2b). In the case of fly-tipping, these goals concern the environmental impact (pollution) in the places of interest, the aesthetic quality of those places and the financial cost of removing the waste (Webb *et al.* 2006). Looking at this issue in this way allows us to better take into account the broader effects that interventions intended to address crime might also have on these goals. Before settling on a fly-tipping intervention, practitioners might therefore ask: what is the environmental impact of the proposed surveillance system?

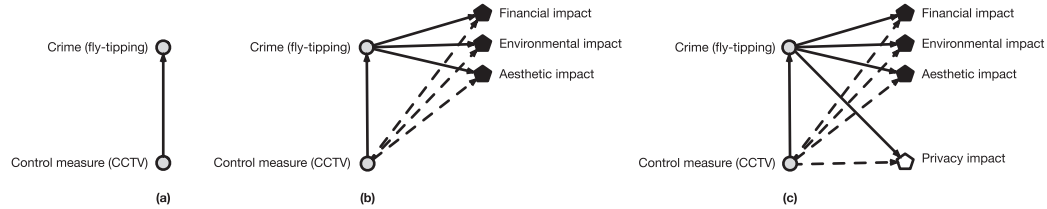

FIG. 2 Different illustrative representations of the problem for the case of illegal waste disposal: (a) based on the narrower definition where the objective is limited to crime reduction; (b) based on the goals affected by crime events and (c) based on a wider set of stakeholder goals.

What is the cost of deploying and maintaining it? How visually pleasing are the cameras? Zooming out further to consider wider goals not initially affected by fly-tipping can also reveal an even greater range of unintended (positive or negative) consequences that the proposed intervention might cause—e.g., the side-effect of CCTV cameras on people's privacy and other rights (see white pentagon in Figure 2c).

These simple depictions show why the scope of POP-type actions must be broadened. Failing to identify, and then to take account of, the wider network of issues within which a crime problem and potential solutions are embedded, may not only misdirect the intervention but also generate negative side-effects and miss out on synergies. It is also likely to encounter or even provoke resistance among stakeholders with other priorities than crime reduction, reducing the chances of successful implementation. This is a particular concern given that crime problems are often co-localized with other social/economic problems. In this connection, Wiles and Pease (2000) discuss an 'all-hazards' approach in which the term 'community safety' was only appropriate if it covered not just crime problems but also addressed a range of other natural and human risks, noting that these are often co-located with crime and may share common causal roots. Wilson and Kelling (1989) and Ekblom (1986) note the arbitrariness of which agency gets to deal with a problem first brought to the police usually in an emergency. Given all this, it is clear that POP (or its wider partnership counterpart) requires a reconceptualization that simultaneously enables a sharp, rigorous focus on crime whilst simultaneously enabling both analysis of and address to multiple dimensions of problems, dealing with the concerns of multiple stakeholders and remits of diverse 'dutyholders' and handling multiple causes. Whilst problem-oriented practitioners struggle to do their best (for all of them pretty rapidly become aware of such issues), it is up to practice- and policy-oriented researchers to help develop the thinking tools for articulating and performing well in this wider operating environment.

Cross-Disciplinary Perspectives on Problem-Scoping

To illustrate the importance of comprehensive problem-scoping and corresponding impact evaluation in POP, we draw upon experts in architecture, biodiversity conservation, industrial ecology and ethics. These fields were selected because they are concerned with a diversity of global issues (e.g., the effect of the built environment on people's activities, the effect of human activities on wildlife and the natural environment and

the effect of human activities on people's rights) and poorly designed crime reduction measures might interfere with each of them.

These experts (the last four co-authors) were selected through convenience sampling, based on their having both a prior understanding of crime science and the problem-oriented approach and diverse professional backgrounds. Each of them was asked to illustrate how interventions implemented for the sole purpose of crime reduction might have adverse impacts in their own disciplinary domains. These cross-disciplinary perspectives are presented individually in the following sections, before being synthesized in the section Moving Forward: Second Generation POP.

Architecture

Architecture, here seen as the designed and built material environment, is always a result of complex negotiations of priorities for various actions and activities (Anderson 1984; Lundequist 1995; Nelson and Stolterman 2003). Rather than an instance of direct causality, the link between architecture and behaviour, e.g., is one of tendencies and affordances (Hillier and Hanson 1989; Gibson 2014). This means that specific designs will have both intended and unintended outcomes; the same use can be promoted by different designs and the same design can be used in radically different ways (Peponis 1989; cf. Markus 1993). Because measures taken to prevent certain actions making crime more likely to occur limit the possibility of other (legitimate) actions or satisfaction of other goals (e.g., avoidance of inconvenience from complex door entry systems), unintended consequences are an essential aspect of design that must be carefully considered. Moreover, for a majority of intended as well as unintended uses, design work deals with likelihoods, encouragement and discouragement rather than making certain behaviours physically possible or impossible.

Regarding the focus of this article, the Crime Prevention Through Environmental Design (CPTED) approach promotes designs that encourage natural surveillance (Jacobs 1961; cf. Newman 1972), access control and territoriality with conflicting results depending on the type of crime addressed (e.g., Desyllas *et al.* 2003; Schneider 2005; Németh and Schmidt 2007; Johnson and Bowers 2010; Hillier and Sahbaz 2011; Borrion *et al.* 2019). It is often argued—commonly based on Jacobs (1961)—that measured crime rates are reduced and sense of safety increased through social bonding, neighbour recognition and other formations of social relations (Kitchen 2005; Samuels 2005; Németh and Schmidt 2007; Hillier and Sahbaz 2011). Looking at the relations between these and architectural tendencies, the security measures that can support some aspects of safety and security may 'internally' conflict with other security measures and further conflict with other goals (Cozens *et al.* 2005; Borrion *et al.* 2012; Armitage 2013), e.g., surveillance (clear sightlines) with defensibility (high walls; Ekblom 2011b).

That is, while specific security features, such as bollards or a set-back of buildings from the street (e.g., Little 2005), do not physically prevent people from entering a building or making use of it, they can significantly alter the social interface as described by architects, which is likely to affect its subsequent use, albeit the degree of impact and the balance between desirable or undesirable effects vary between building programmes. For instance, shops dependent on drop-in customers may suffer noticeably from such interventions, whereas others may remain unaffected depending on

how they develop customer relations and how they conduct their business (Miller *et al.* 1998; Zukin and Kosta 2004; Koch 2007).

To illustrate, consider the design of parks: designs that allow good natural surveillance and sense of safety may also make it impossible for children to play hide-and-seek (Koch 2016). Conversely, small nooks and crannies in cities and smaller shielded spaces in parks facilitate a wide range of positive informal activities and encourage social bonding (e.g., Kärrholm and Sandin 2011). However, they can also increase the feeling of insecurity, while there is also evidence these may be places where certain types of crime tend to happen (cf. Ceccato 2014).

In both these cases, consequences of different design choices must be carefully weighed against one another, and the palette of activities included in those considerations should be sufficiently broad and diverse to encompass a wide set of social actions. This is because public space should allow a wide range of activities and differences to co-exist, either simultaneously or over time, and for negotiation of public culture to take place (Zukin 1995; Kohn 2004). Designers and architects can often use creativity to develop designs which can simultaneously meet potentially conflicting requirements—e.g., *walls* could be made transparent to deliver sightlines *plus* defensibility. The ways in which security measures operate depend on contextual elements and, if applied slavishly in situations other than those intended, may cause more issues than they solve (Rondeau *et al.* 2005).

As shown in these examples, integrating crime prevention measures into architectural projects can be difficult because of their effects on social bonding, interaction and the presence of others as well as on the opportunities for a range of desirable activities. Other concerns exist. For example, regarding the symbolic values of expressing security measures and the socio-cultural consequences of an 'architecture of fear' (cf. Ellin 1997; Gamman and Thorpe 2007), although CPTED has developed considerably more balanced approaches since this phrase was coined (e.g., Home Office 2004; Ekblom 2013). Also important is the enablement of subcultural practices in relation to an integrated and comprehensible whole (Williams 2011; Amin 2012). As an additional challenge, architecture is characterized by largely handling what has been termed 'wicked problems' (Rittel and Webber 1973), where problems cannot be exhaustively formulated, there is no exhaustive list of operations to work with, every problem is a symptom of another problem and while experience and knowledge is built over time, solutions are essentially one-shot solutions. These are challenges shared with both crime prevention and planning (e.g. Conklin 2006; Borrion and Koch 2017; 2019).

Such conflicts between values are discussed in CPTED, for instance as 'troublesome trade-offs' (Ekblom 2010, 2013), highlighting the need to creatively balance values both within crime prevention efforts and between such efforts and other values. An attempt to take this further and creatively develop a 'vibrant secure function framework', which seeks to address what street users want 'more of' as well as 'less of' is in Willcocks *et al.* (2019). Achieving safety and security in a way that is fully integrated with other architectural requirements must therefore deploy the full range of questions to ensure that design choices result in what architects, tasked to design for the client's wished results alongside wider societal requirements, would consider an acceptable outcome (cf. Thorpe and Gamman 2013).

Biodiversity conservation

Efforts to reduce crime in the context of biodiversity conservation present several challenges; solving them requires successful integration of expertise from a broad range

of disciplinary perspectives. First, crime reduction measures must be designed in ways that do not produce negative ecological consequences. For example, fencing a protected area might be proposed as a strategy to reduce poaching, targeting both the motivations of and opportunities available to poachers—e.g., by reducing crop raiding by elephants and limiting poacher access, respectively (Packer *et al.* 2013). However, by limiting the movement of the species it is intended to protect, fencing can sometimes do more harm than good (Newmark 2008). Understanding the biology of species and ecosystems is therefore key to understanding when and where specific approaches might be suitable and how best to resolve universal trade-offs in local circumstances.

Second, crime reduction strategies must be designed in ways that do not produce unacceptable negative social consequences. Biodiversity is concentrated in poorer regions of the world (Fisher and Christopher 2007), and the costs of conservation have often fallen disproportionately on poor people (Balmford and Whitten 2003). Poverty has been widely cited as a factor driving the illegal use of natural resources (Duffy *et al.* 2016), so crime reduction measures in conservation should also be designed in cooperation with development practitioners and fully integrated into broader development strategies to ensure that they achieve sustainable and equitable outcomes.

Finally, the 'wicked' side of problems in conservation and environmental crime prevention (see Mason *et al.* 2018) can pose significant practical challenges for the application of problem-solving models. Crime reduction strategies should be designed to balance the needs of all relevant stakeholders. However, in the context of conservation, it is often difficult to identify who these stakeholders are; their interests, moreover, may be in direct conflict, and there can exist significant imbalances in power between them (Redpath *et al.* 2013). Considering again the example of poaching from a protected area, the most obvious stakeholder groups might include the local people living around its borders, park staff, government officials and ecotourism operators, but conservation NGOs and the broader international community also regularly claim a stake in the survival of threatened species. In such settings, insights from anthropologists, historians and political economists with local expertise can play a vital role in ensuring that all stakeholders are identified and that imbalances in power do not unfairly constrain proper consideration of their interests (Brockington 2004).

Industrial ecology

The link between law enforcement and the environment is not confined to environmental crime, i.e., offences deliberately intended to damage or illegally take from the natural world. Beyond legality, ethicality and public acceptability, citizens and organizations are increasingly asked to consider the unintended impacts of their actions on the environment. Law enforcement is no exception, and similar efforts are required from those designing and implementing crime reduction interventions and security technologies (Armitage and Monchuk 2009; Pease 2009).

Pease and Farrell (2011) pointed out the environmental impact of police car patrols, and the contribution that other forms of crime prevention measures could make to reduce CO_2 emission. CCTV is an example of equipment that is extensively used for crime control but whose effects on the environment are overlooked when urban security plans are developed.

While adherence of video surveillance to ethical principles has been extensively examined, little is known of the effects of CCTV systems on the environment. As the number of cameras increases across the world, the environmental consequences of CCTV systems should no longer be ignored.

In particular, operation of CCTV cameras often requires long-hour consumption of electricity, which impacts the amount of greenhouse gas generated and fossil fuel consumed. The impact of individual CCTV systems is usually low compared to other household appliances (such as refrigerators), but with the sheer number of cameras installed, it is important that the design of CCTV takes energy use into account. Equally, designers should also consider, e.g., whether their proposed CCTV system is expected to operate using renewable energy (e.g., solar), which might conflict with other requirements. The running of data servers to store the large outputs of data from CCTV may also have a significant energy impact.

Another consideration is that CCTV equipment is constructed from a range of materials including semiconductors. When they are designed, little thought is given to how cameras can be recycled or valuable materials recovered at the end of their lifespan. With the increasing demand on natural resources, the EU requests that all new product designs maximize their resource efficiency. With CCTV cameras, components (e.g., semiconductors, plastics and glasses) can be recovered. However, the recovery process is often expensive and energy intensive due to the lack of prior consideration during the design stage of deconstruction and recycling.

In addition to issues with material recycling, the fabrication process of certain parts of CCTV cameras, such as semiconductors, is demanding of abrasive chemicals, water and electricity (Williams *et al.* 2002). The raw material extraction and manufacturing process could also contribute to environmental damage from mining, use of petroleum-based plastics, atmospheric emissions, use of chemicals and exposing people to toxins. Unfortunately, this aspect of impact from raw materials or component manufacturing is often overlooked (ibid) as attention centres on the use phase of the cameras. To avoid shifting problems and develop a clearer picture on where designs might be improved, the whole lifecycle impacts of CCTV systems should be examined, including material extraction, manufacturing, distribution, use and end-of-life disposal.

Because of manufacturing limitations, however, the solution to this issue is unlikely to be addressed solely by improving the design of cameras. As with many other technological products, the implication is that CCTV planners should optimize the configuration of CCTV networks (e.g., reduce duplication) and improve their efficacy in reducing crime. They should also consider whether alternative, less environmentally impactful means of achieving surveillance could sometimes be substituted.

Ethics

The aforementioned arguments not only apply to the implementation of interventions by law enforcement agencies but also to the socially acceptable design of *security technologies* (i.e., technologies for preventing or detecting crimes and/or enhancing the security of individuals, their property or the state). A diverse range of such technologies are developed and employed with the aim of reducing crime. Examples include: airport whole-body scanners designed to identify metallic and non-metallic items concealed

within/under the clothing of passengers (Mitchener-Nissen *et al.* 2012); biometric databases which assist in identifying and prosecuting offenders (Goldstein *et al.* 2008) and data mining techniques for identifying evidence of criminal activity from large data sets (Steinbock 2005).

The fact that these security technologies are designed and implemented to achieve crime reduction goals has not insulated them from public criticism. Each of the above examples has had its operation curtailed or terminated due to public criticism translated into political action. It is arguable that the design processes behind these technologies, involving closed communities of designers focussed primarily on the reduction of crime, have had a negative impact on the final crime control measures that were implemented. This theme is taken further in Gamman and Thorpe (2007) who refer to 'vulnerability-led design'.

This leads us to assert that had expertise from other domains been incorporated upstream in the design process—via (1) the identification of wider requirements (beyond those objectives directly related to the primary *function* of the intervention) and (2) the assessment of ethical risks—then the final security technologies would have been better placed to achieve their crime reduction goals without undermining support from the very public they were introduced to serve. When proposed crime control measures are likely to have an impact on society, experts from domains including ethics, human rights and public engagement should be co-opted; as should representatives from any minority groups within a society upon whom the operation of that security technology will place a greater burden. This reflects the reality that crime reduction measures operate not in a vacuum but in societies comprised of many different groups possessing a diversity of values and goals and that without the broad support of these societies, a crime control measure will lack legitimacy and may well fail to be accepted or to operate as intended. Ekblom (2011a) refers to this issue as 'climate setting'.

On the design of security technologies, if the initial design process itself is restricted to crime reduction practitioners (specifying what products should do), and a few engineers/scientists (designing end products to accomplish those functions), the end products would probably fail to satisfy or even hamper the needs of many people and organizations, magnifying the risk of the products being rejected by the clients or society (Borrion 2019).

Involving experts from other domains is important but it is unlikely to be effective if this done too late in the process. Using backscatter whole-body scanners as an example (Carter 2012), these were (cf. Shapland 2000) developed and deployed within UK airports without wider consultation and led to social controversies over both the perceived health risks involved and the revealing nature of the scan image produced, likened to a digital strip-search. The inability of the designers to address these concerns in a timely manner post-deployment resulted in the backscatter versions of whole-body scanners being removed from all UK and US airports. This has reputational consequences for both the developers and the security practitioners associated with this technology. Adopting an iterative design model whereby a wider range of experts are empowered to contribute at the early stages of the design process would act to minimize the likelihood of such costly outcomes, as can co-design involving practitioners and end users. Happily, in this instance, retrospective changes to scanner designs have alleviated the problem (Ahlers 2013)—but a lot of embarrassment, suspicion and cost could have been avoided by forethought.

Moving Forward: Second Generation POP

Central to the argument of this article is the premise that the impacts of police interventions and other crime reduction measures are not confined to crime rates. Indeed, many interventions have wider unintended positive and negative consequences. To scope problems and design suitable interventions (or select amongst different alternatives), we must recognize that their effects may (1) be of various ethical, legal, social, cultural, environmental, commercial or economic natures and (2) fall on various individuals, communities and organizations and affect their interests and the natural environment in diverse and sometimes conflicting ways. Ensuring that the negative consequences of crime reduction interventions are kept to an acceptable level, and that positive ones are explored and exploited, is an integral part of designing and implementing suitable interventions for several reasons:

- Crime reduction (reducing the frequency of criminal events)—although an organizational and political goal in itself—is justified by higher-level goals (e.g., harm reduction) (Greenfield and Paoli 2013), and therefore interventions should respect the broader needs of the population, including positive ones (e.g., support well-being; cf. Willcocks *et al.* 2019).
- Interventions could be ineffective or even counterproductive if, besides triggering new crime reduction mechanisms, new control measures concomitantly make existing ones ineffective or generate the same or other crimes in other ways (e.g., via reducing social cohesion, creating new criminal opportunities or provoking potential offenders).
- Ultimately crime control measures are unlikely to be implemented (at least over a sustained period) if their wider impacts are deemed unacceptable to decision makers. By the same token, if crime control measures additionally confer broader benefits perhaps to a broader range of stakeholders, they are more likely to be adopted and maintained.

Despite this, we observe that the problem-solving models and evaluation frameworks used by criminologists, and the practitioners that follow their guidance, are almost always restricted to crime (and usually crime rate, though recently harm reduction has received greater prominence). More generally, prevention by definition involves tackling the *causes* of crime (Pearl 2009). Many of these causes will reside in domains of society at some remove from crime—economy, manufacturing, culture, leisure etc.—and addressing them will inevitably mean encountering conflicting priorities and values (Alrajeh *et al.* 2018). From these points, we make three recommendations in the following sections.

Aligning the definition of 'problem' on those used in other disciplines

Whether problem-solving works is intimately linked to the formulation of the problems addressed. In the literature, Goldstein and Eck have described them as related by common causes:

> First, problems are groups of incidents, not singular events. Second, the elements in this group are connected in some meaningful way, not random or arbitrary. These two elements suggest that the

events that make up a problem stem from the same underlying cause. The third element requires that the incidents be disturbing or harmful to members of the public, not just to the police. (Eck 2003: 82)

Criminologists often describe the problem as the 'manifestation of crime events'. This is based on the meaning of the Greek word 'problema' (i.e., obstacle), and refers to the obstacle that police are asked to deal with to create a sustainable society. As found in the wider literature about problem-solving, this definition is neither the only one nor the most useful in our view. Goldstein (2018a: 388), e.g., extends it by referring to a problem as 'an obstacle between a *present state* and a *goal* and it is not obvious how to get around the obstacle'. Others focus on the other two elements: Greeno (1978) explains that 'a problem consists of an initial state and a goal', Jonassen (2000) that a problem exists when there is a 'difference between a goal state and a current state'. Wood (1983) also included the concept of constraints along the paths: 'a problem consists of: a set of initial states, a set of goal states, and a set of path constraints'.

Following wider problem-solving approaches, the practical problem addressed by crime reduction practitioners is therefore not merely the obstacle (i.e., the manifestation of crime events) but the 'generation and selection of discretionary actions to bring about a goal state' (Scandura 1977). Furthermore, the goal state should not be merely be defined in terms of removing the obstacle but instead achieving the wider set of goals that suitable interventions are expected to meet. Those include, but should not be limited to, keeping crime under acceptable levels through enforcement of the law. The goal-state perspective is implicit in Sparrow's (2016) conception of POP in terms of risk-based regulation (the performance standard being the goal state), but we believe it should be explicit.

Aligning us with problem-solving frameworks in other disciplines and professional sectors and acknowledging the wickedness issue and the particular approach of Sparrow, the term 'problem' could therefore be redefined as follows:

the *problem* is one of how to intervene to reduce crime to acceptable levels, whilst also satisficing the wider set of goals of all stakeholders.

Improving problem formulation

Redefining *problem* allows us to operationalize this concept for problem-solvers and beyond the sole objective of crime reduction. As an example, we borrow from an emerging disciplinary domain increasingly relevant to crime prevention, within which problem formulation has been extensively formalized: Artificial Intelligence (AI).

An AI problem-solving task typically involves: problem formulation, goal formulation, a search strategy and the development of computational mechanisms (algorithms) that use this strategy to find a solution. Early categorization of algorithmic problem-solving methods considered a three-way division: state-space approaches, problem reduction approaches and formal logic approaches. Each of these approaches proposed its own means for instantiating the problem-solving process (Nilsson 1970). Perhaps closest to Scansura's view on problem-solving (see also Wood 1983) is that of state-space approaches, and therefore we focus on this approach as opposed to the others just mentioned. Under this view, a *problem* is formulated as three components: an initial state,

a search space and a goal test (Russell and Norvig 2010). In this formulation, a *search space* is a set of states, a set of actions, a description of possible actions available from any given state, a description of the effect of executing an action on a state and a cost associated with executing an action in a state. A *goal* is defined as a set of desirable state(s) in which specific objectives are achieved. A *goal test* checks whether a goal state has been reached. Goal tests may be multi-objective, requiring some goals to pass clear-cut criteria whilst others are more loosely appraised. A *solution* is a sequence of actions (i.e., a path) leading from the initial state to a goal state. A *solution cost* is the sum of action costs appearing in the solution. There may be several solutions for a single problem; the solution with minimum cost is called an *optimal solution*.

To contextualize these concepts, let us consider the aforementioned case of illegal waste disposal. The problem formulation in state-space terms is presented in Table 1. For each of the themes discussed in Cross-Disciplinary Perspectives on Problem-Scoping, we consider here only a few features to illustrate how problem-solving for policing could be formulated.

Hence, within the context of crime reduction, an AI problem-solving view is one that aims to find suitable intervention actions that, within the space of possible activities, would lead to overall reduction in successful crime rates with minimal composite levels of financial, environmental, aesthetic and privacy impacts. The adoption of such an approach in POP provides a much richer definition of the problem and encourages analysts to identify the wider range of information needed to solve crime problems.

Improving problem-solving process models

To ensure crime control measures meet the goals and constraints of stakeholders, strengthening problem formulation alone is insufficient. A multicriteria approach must also be adopted throughout the entire problem-solving process.

To arrive at a solution that best satisfies the various stakeholders—a concept known as the Nash equilibrium in game theory (Nash 1951)—*every* design decision should ideally be informed by an evaluation of its effects against not just one but all selected criteria. This is because most design decisions constrain the pool of options available at future decision points, and whilst one decision may be optimal in terms of crime reduction, their impact on other goals (cf., financial cost, environmental impact) could be disastrous.

In practice, this implies that problem analysis must be driven by several goals in parallel rather than sequentially, that scenarios should not be restricted to crime scripts (see Cornish 1994; Borrion 2013) but also include events other than crime events that hinder the satisfaction of the stakeholders' goals, that reasoning activities in design must be based on information from more than one disciplinary domain and that impact evaluation must apply multiple criteria (cf., Ekblom 2011b: 56; Dorst 2015: 49; Sparrow 2016: 88).

Retrofitting existing frameworks to give them a multicriteria dimension may be possible. In SARA, the guidance about the Assessment stage could be modified to indicate that an intervention should be assessed against several criteria (e.g., financial, environmental). This would be fairly easy and would not require structural changes because these required assessment tasks can be performed by separate experts in parallel.

Table 1 *Problem formulation (abridged) inspired from Artificial Intelligence applied to the illegal waste disposal example presented earlier.*

Component		Example
Initial state		A description of the place victimized and its environment (e.g., terrain, road network, CO2 levels) and all key actors (e.g., offenders, individuals/organizations potentially sourcing waste, guardians, bystanders, council) who could influence the stakeholders' needs
State space	Possible states	The set of situations in which the place, its environment and actors may be with respect to all relevant factors
	Possible actions	The set of decisions and activities of the relevant parties at different points in time. These actions include the crime commission process as well as the interventions (e.g., acquisition, deployment or operation of a network of CCTV cameras).
	Action effect description	Given a state and an action, what the resulting state is: e.g., if we 'enhance CCTV surveillance' in hot spot areas, the model would hypothesize the likelihood that the offender disposes of the waste in the same place, disposes of the waste somewhere near or far away (geographical displacement) or reduces their fly-tipping activities or even disengages
	Cost	Informed by the financial impact, environmental impact, aesthetic impact, privacy impact associated with each intervention (e.g., street light installation, additional patrol effort)
Goal test		E.g., Has the volume of fly-tipping decreased?

However, the design of a suitable intervention cannot always be distributed between several domain experts, each in charge of a different goal (and type of impact). This is because the design of a single intervention requires regular integration of information from multiple domains and addressing conflicts and trade-offs.

This challenge is not novel though. It has been rather successfully addressed in systems engineering through the definition of *stakeholder requirements* and *system requirements* (IEEE 2015; Borrion 2019). In practice, the needs of the different parties are elicited, analysed and documented as statements about the specific goals and constraints to be met by the system to be developed or retrofitted (van Lamsweerde 2004, 2009; Letier and van Lamsweerde 2004). Possible obstacles to the achievement of the elicited goals (including inconsistencies) that may be present in the environment are detected, assessed and used to guide both the requirements elaboration and the processes of creation and decision-making within the design process (see Alrajeh *et al.* 2016). In a similar vein, Ekblom (2012) notes how TRIZ, the 'theory of inventive principles' in engineering, design and social innovation, explicitly articulates contradictions in design requirements (such as strength versus weight, or privacy versus security) and that doing so paradoxically makes it easier for innovative solutions to be found, which realize both benefits simultaneously rather than a poor compromise.

Introduction of this stage in POP models would encourage practitioners to analyse the problem more deeply before selecting a solution (Read and Tilley 2000) and help identify conflicts between different goals (e.g., security versus privacy) of the stakeholders and obstacles within the environment (e.g., blocked surveillance cameras).

Conclusion

Goldstein's problem-oriented approach remains a remarkable contribution to policing. The problem-solving models proposed to operationalize it are also part of its intellectual

legacy. To fully embrace this philosophy, criminologists must, however, go beyond Goldstein's seminal article and acknowledge the multifaceted aspects of the problems of interest. By the same logic that justifies the contention that businesses should be mindful of the criminogenic properties of their products and services, crime reduction practitioners should aim to implement the crime intervention with acceptable social, financial, ecological and ethical consequences. In practice, this requires revising the concept of problem and aligning problem-solving models with the multicriteria frameworks found in other disciplines, including design, engineering and risk management. This also means reconsidering the role of police officers and other crime reduction practitioners within a broader multidisciplinary frame and—in moving from the consensual goal of reducing crime to a wider arena of policy issues engaged by preventive interventions in the *causes* of crime and to the reconciliation of security with other policy requirements—acknowledging the political dimension of the problem-oriented approach.

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