Organising Patrol Deployment against Violent Crimes

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Abstract
Violent crimes such as ram raids and armed robberies have a substantial impact on the physical, emotional and material wellbeing of victims. Therefore these crimes typically receive the highest priority from the police. In this paper we present prescriptive models to deploy police patrol units to improve their ability to respond timely to such crimes. These models can also help police administrators to assess the effectiveness of proposals that attempt to advance the moment when the police arrives on the scene. The models are illustrated by an application to real-life data from a Belgian police zone from which some general guidelines are derived.

Keywords: posting of police units, patrol deployment, violent crimes

1. Introduction
Ram raids, armed robberies and similar violent crimes typically receive the highest priority from the police because of the enormous impact they have on the physical and emotional well-being of victims, apart from financial and material repercussions. Unfortunately, sometimes the media have to report another dramatic ending where the police failed to adequately respond to the event. After such an occurrence public and media typically scream for decisive action from police and politicians to prevent, or at least reduce the probability of another such occurrence or outcome. Politicians are then tempted to rapidly articulate ideas that hopefully improve police effectiveness. Proposals range from the deployment of more police patrol units, over more directed patrol activities on potential crime sites, to even fiscal compensations for safety investments made by businesses such as for example the instalment of an alarm system.

Many proposals attempt to advance the moment when the police arrives on the scene of the crime. It is believed that the sooner the police arrives the higher the chances are of an on the scene arrest or the easier it is to set up a successful perimeter to intercept fleeing criminals afterwards. Police administrators claim that even when criminals
already fled the scene a timely response may be worthwhile. The tracks are still fresh and potential witnesses are still in the vicinity of the crime scene so that an effective pursuit may be undertaken.

While the damages caused by these crimes can be huge, so is the price tag on some of the proposals launched to prevent them. In Belgium the cost of one additional two-officer patrol unit that operates around the clock during one year is estimated at 750,000 euros in personnel costs alone. A relevant question is then which proposals are most cost efficient and how capacity is best deployed to be as effective as possible.

In this paper we analyse two optimisation models to deploy police patrol units to minimise the probability that no unit arrives within a statutory time in any of an identified set of potential crime sites. In the first model, each police unit is given instructions to patrol the quarters of an area (at a prescribed frequency) independently of another unit. Thus, when patrolling, a particular unit is not interested in the location of another unit. In the second model, police units operate in specific formations. At all times, the different units are arranged in strategic deployment patterns to guard the area. While the former policy is easier to realise in practise, we prove that it is dominated by the latter.

Both models, a signomial and a linear programming problem, allow to evaluate the effectiveness of alternative measures that attempt to advance the moment of arrival of the police on the scene. They provide police administrators with a tool to design patrol deployment patterns that improve effectiveness against ram raids, armed robberies and similar violent crimes.

The structure of the paper looks as follows. In the following section we describe the relevant police system, followed by an overview of relevant literature. In Section 4 we develop both models to deploy police capacity and prove domination of one policy over the other. As an illustration both models are applied to a Belgian test case, after which we formulate our conclusions.

2. Problem Environment

The focus in this study is on the police intervention function as performed by patrol units. If a ram raid, armed robbery or similar “violent crime” occurs it are typically these units to respond first.

To facilitate the operational organisation of patrol and intervention activities police administrators typically divide the terrain in sectors. A sector is usually a contiguous and compact gathering of quarters, census tracts or other atomic geographical entities which we will address as “atoms”. These atoms are non-overlapping and cover the entire territory of the police zone. At least one patrol unit is assigned to each sector.