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Repetitive deliberate fires: Development and validation of a methodology to detect series

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ABSTRACT

The detection of repetitive deliberate fire events is challenging and still often ineffective due to a case-by-case approach. A previous study provided a critical review of the situation and analysis of the main challenges. This study suggested that the intelligence process, integrating forensic data, could be a valid framework to provide a follow-up and systematic analysis provided it is adapted to the specificities of repetitive deliberate fires.

In this current manuscript, a specific methodology to detect deliberate fires series, i.e. set by the same perpetrators, is presented and validated. It is based on case profiles relying on specific elements previously identified.

The method was validated using a dataset of approximately 8000 deliberate fire events collected over 12 years in a Swiss state. Twenty possible series were detected, including 6 of 9 known series.

These results are very promising and lead the way to a systematic implementation of this methodology in an intelligence framework, whilst demonstrating the need and benefit of increasing the collection of forensic specific information to strengthen the value of links between cases.

1. Introduction

Deliberate fires are known to be one of the most difficult offenses to understand, detect and solve [1–3]. In a previous paper [4], we identified and described how three major challenges impact negatively on the resolution of deliberate fires. These were, the lack of definitional consensus around the notions of 'deliberate fire' and 'perpetrator', the concealment of relevant events within legitimate cases, and the dispersion of investigatory data across disparate multi-agency systems.

Further, relying on studies from other types of repetitive crime [5–14], as well as the repetitive nature of some types of deliberate fires, we argued that a forensic intelligence framework could play a significant role in detecting, understanding and eventually reducing the occurrences of repetitive deliberate fires.

This second paper addresses the particular issue of the detection of deliberate fires lit by the same perpetrator (i.e. series). Detection is recognized as being one of the most challenging steps of the intelligence process [15]. Indeed, detecting implies the ability to recognize something, often concealed, defined as relevant. The detection of recurring events relies on the assumption that these events share similarities or at best are identical (that is because a common cause is the most probable explanation behind similarity [15]). Therefore, the detection of repetitions assumes the ability to recognize similarity between various events, in our case, fires. Adding to the challenge is the need for this detection to occur in a limited timeframe, in order to remain relevant, suggesting an efficient (even automated) system in place.

This study will present and evaluate the performance of a methodology developed to detect series using a dataset of deliberate fires, comprising of unrelated cases as well as cases known to be in series, thus allowing an assessment of the potential of the methodology.

2. Intelligence-led policing, the intelligence cycle and forensic intelligence

The intelligence-led policing concept is based on observations that a majority of criminal offences are committed by a small minority of offenders, often in localised areas [16,17], and that crime follows patterns, with offenders demonstrating some

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relative consistency in behaviour during the crimes [18–20]. This process uses data available to provide the big picture and enables the detection of specific problems and repetitions, leading to more proactive and targeted actions.

The transition from data to intelligence is done through a set of stages organised into a process called the intelligence cycle (Fig. 1).

Forensic intelligence is "the accurate, timely and useful product of logically processed forensic case data [i.e. traces [22]] for crime investigation and crime analysis purposes" [23]. To date, the use of traces has been mainly considered within the framework of a specific case: either to assist inquiry during the investigative phase, or to gather structured evidence for the court process. However, the potential contribution of traces (alongside other types of data) outside of this framework, in assisting with the detection of crime repetitions and patterns, although recognised for a long time [24], is still underused [25].

In line with the three levels of intelligence [7,16], three types of repetitions are distinguished: phenomenon, situation and series. Phenomenon and situation can be referred as recurring repetitions reflecting general criminality, serial crimes and criminal organizations [14,26].

Phenomena are a group of repetitive events, following a certain cycle and without any geographical limits (e.g. credit card skimming). They are not due to a specific perpetrator but are a more general behavioural pattern. In the context of deliberate fires, experience indicates that the following phenomena could exist: vehicle fires, trash/bin/container fires and fires in business premises. However, their existence has never been formally proven.

A situation is a combination of circumstances surrounding a fire event. For example, a location, a time, a date and a fire friendly environment (concurrent presence of combustible material, a heat source and an oxidant). In the field of non-deliberate fires, many situations have been described such as Christmas tree fires at the end of the year in Europe, or fires started by cigarettes on mattresses [27,28]. Situations are yet to be identified in the context of deliberate fires.

Finally, series are specific repetitions due to specific individuals. In the context of fire investigation, series correspond to repetitive fire sets by a unique perpetrator (or a group of perpetrators), regardless of the motivation to set fire.

3. Development of a methodology to detect series in a data set

Detection is a key issue and potentially one of the most challenging steps in the forensic intelligence process. The aim of this paper is to present a methodology to detect deliberate fire series, i.e. a group of events (in our case deliberate fire events) occurring repeatedly.

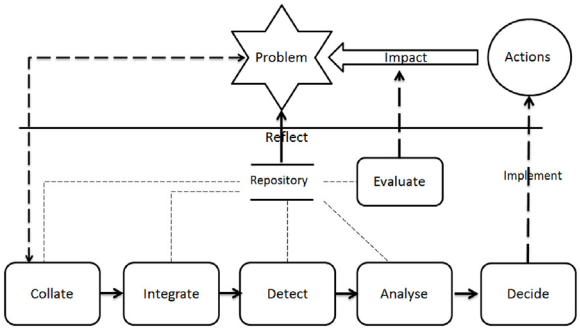

Fig. 1. The intelligence process, adapted from Ref. [21].

Knowing this, the first question to address in the development of a methodology to detect series is: what are the elements of a deliberate fire that are likely to be similar/constant between different events perpetrated by the same person, hence demonstrating a common source and a repetition?

3.1. Constant elements between deliberate fires set by the same perpetrator

Elements can be defined as variables present in every event, representative and specific of it. They must be easily and readily observable and easily understood by people interacting with them [11,26,29–36].

The determination of these constant elements for deliberate fires was done through a literature review.

According to the literature, the following elements are likely to demonstrate consistency between events committed by the same person: geographical, temporal, modus operandi and forensic traces (including elements of fire investigation) [29,37–39].

3.1.1. Geographical element

The geographical element refers to the address of the event and its geospatial coordinates.

The location of a crime is recognised to be central for crime in general but also for deliberate fires, as studies show that perpetrators tend to act close to their home or areas surrounding them, also called "routine activity node" [40], typically including a person's home, place of work, places of recreation [41–47]. It is worth noting that "some routine activity nodes will be shared by many people (e.g. city centres) (. . .), but others will be more unique to particular individuals (. . .). It is where the activity spaces of many offenders overlap that hotspots of crime are most likely to form" [48].

Further, particular to the case of deliberate fire, another reason suggested for limited travel is the possibility of restricted mobility for fire-setters [49].

That said, this geographical proximity has to be defined. A small number of studies, in various countries, have been conducted to determine the distance of the journey for an offender to the crime site (lighting a fire) and their results are comparable.

A study in Australia [50] showed that 82% of 22 fire setters exhibited a marauder pattern as described by Canter and Larkin [42], i.e. committed crimes around their home. A study in the UK observed that the average distance travelled to set a deliberate fire was 0.9 miles (about 1400 m), with 70% of fire setters travelling less than 0.75 miles (about 1200 m), 49% less than 0.25 miles (about 400 m) [45]. It was also found that the younger the perpetrator the shorter the distance travelled (0.1 mile for a 10 year old, 1 miles for a 17 year old). A Canadian study observed that repetitive fire setters travelled on average 1.45 km [51], with a majority of the objects set on fire located in a range between 250 m and 2 km from the house of the perpetrator. Finally, a study conducted in a state in Switzerland revealed that out of 28 solved series, seventeen perpetrators lived within 2 km from the fires, eight between 2 and 10 km and three between 10 to 30 km [52].

Currently, through this geographical criterion, hypotheses and suspicions of series are commonly raised [53–56].

Nevertheless, it should be noted that in cases where the target is central to the act, especially in cases committed with motives such as revenge, insurance gain and pathological conditions, a commuter pattern is more likely to occur [57].

3.1.2. Temporal element

The temporal element refers to the time of the event as well as the day of the week, month, year, season, or even possibly type of day (such as a public holiday for example).