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The Effects of Deprivation on the Time Spent Examining Crime Scenes and the Recovery of DNA and Fingerprints

ABSTRACT: DNA and fingerprint identifications are now accepted as an integral part of the investigation of a wide range of criminal offences from burglary and auto crime to serious and major crime. Despite this, there is still much variation between U.K. police forces in the recovery of fingerprint and DNA material from crime scenes. Analysis of burglary and auto crime data for Northamptonshire, U.K., during a 3-year period has enabled an examination of the relationship between the deprivation of the neighborhood in which the crime was committed and the level of service provided by Crime Scene Examiners. The results indicate that the time spent examining a crime scene for forensic evidence is not affected by the deprivation of the neighborhood. Further, there is no statistical significance between deprivation and the recovery of fingerprints from the crime scene. The relationship between deprivation and DNA recovery is, however, statistically significant with DNA being recovered more frequently from less deprived neighborhoods.

KEYWORDS: forensic science, DNA, fingerprints, deprivation, crime scenes

Forensic intelligence from DNA hits and fingerprint identifications is now accepted as a standard forensic technique for the investigation and subsequent detection of a wide range of crime types from volume crime (such as burglary and auto crime) to serious and major crime such as rape and murder (1,2). Despite this, there is still a wide variation amongst U.K. police forces in terms of the recovery of fingerprint and DNA material from volume crime scenes with only 12 of the 43 Home Office forces (The Home Office in the U.K. is similar to the Department of Justice in the U.S.A.) recovering fingerprints from >40% of examined burglary dwelling scenes and only six forces recovering DNA from >10% of burglary dwelling scenes (3). While studies have been carried out to consider the conversion of forensic intelligence into crime detections (4,5), little has been researched to examine the reasons for the variation in the recovery of fingerprint and DNA material from volume crime scenes.

This issue has been previously highlighted by reference to data from a number of U.K. police forces (6,7). The Association of Chief Police Officers and Forensic Science Service (6) noted that, at volume crime scenes, collection procedures (for forensic material) yielded low dividends (in terms of crimes detected) and at a high cost.

Williams (8) noted that, whilst forces with the heaviest Crime Scene Examiner (CSE) workloads had the lowest collection rates for forensic material, the converse was not true in that a light load did not guarantee a high retrieval rate. Williams stated that it was unclear in his study whether low recovery rates were a consequence of the examination of a high proportion of crime scenes (including unproductive scenes), or whether some other (unidentified) factors were responsible.

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More recently, Bond (9) demonstrated that a prioritization of forensic resources and processing over a 6-month study period yielded an increase in the percentage of examined burglary dwelling crime scenes where both DNA and fingerprints were recovered.

In this paper, we seek the answer to the question, ''Does the deprivation index of the crime scene location affect the recovery of DNA or fingerprints and the service offered by CSEs?'' This will be investigated by answering the questions below:

Does the time spent at the crime scene alter depending on the deprivation index of the location?

Is there a link between the recovery of fingerprints and DNA at crime scenes and the deprivation index of the crime scene location?

The deprivation index refers to the Index of Multiple Deprivation (IMD) (10). The IMD contains seven domains of deprivation: income deprivation, employment deprivation, health deprivation and disability, education, skills and training deprivation, barriers to housing and services, living environment deprivation, and crime, each of which are combined to yield the aggregate measure of deprivation. The overall IMD has two data columns:

- Index of Multiple Deprivation Score
- The Rank of the Index of Multiple Deprivation

The IMD 2004 is presented at Super Output Area Lower Layer (LSOA), each LSOA having an average population of 1500 people and a geographical boundary constraint used in the 2001 U.K. Census (if the whole of the U.K. can be termed as being similar to a state in the U.S.A. then the U.K. LSOA can be equated to a U.S.A. county or city geographical area). Using this measure, the LSOA with a rank of 1 is the most deprived and 32,482 the least deprived (11).

A sample of Northamptonshire Police CSE supervisors and staff were interviewed and their operational perspective is that for the volume crimes of commercial burglary (BOther), theft of motor vehicle (TOMV), and theft from motor vehicle (TFMV), a CSE will increase the time spent at the crime scene as the deprivation

index increases (deprivation reduces) but recover slightly more DNA and fingerprints in the most deprived areas, the quantity reducing as the deprivation index of the area increases. This is due to the CSEs' perception that offenders generally reside in the geographical areas that have a low(er) deprivation index rating (more deprived areas) and subsequently offend within their areas of comfort and awareness space (12). This translates into them being less careful and, therefore, depositing more forensic material. A further perception from the CSEs' is that as the deprivation index of the crime scene location falls, the victim is less able or willing to differentiate between legitimate and foreign objects within the property, for example, whether the cigarette ends or drink cans in the car/house belong to the victim or the offender. The perception details above hold true for the volume crime of burglary dwelling (BDwell) offences when recovering DNA but the CSEs believe that substantially more fingerprints will be recovered as the deprivation index decreases. This is due to their perception that, in general, victims are less amenable in that, "…victims from property in low(er) deprivation index areas have homes that are less clean and tidy meaning that there will be more fingerprint deposits that have not been removed for many days." The CSEs will not be able to differentiate between recent, possibly offender, marks and the myriad of other marks within the house.

This analysis of deprivation is of interest for operational policing in ascertaining the level of service offered to victims and the subsequent deployment of CSEs (8,13).

Data Used

For this study crime scene activity data has been taken from Northamptonshire Police, a semi rural police force in the U.K. Northamptonshire Police record all of their crime scene investigation and management data into an ORACLE-based relational database which was written and developed in-house. The system records the following information:

- Location information for each crime scene.
- CSE attendance details such as date/time attending, date/time leaving, and forensic recoveries (these are locally known as "Activities"). Each crime can have several activities.
- Storing and tracking of forensic exhibits and their subsequent matches to individual persons.

Volume crime forensic data between 1st April 2003 and 31st March 2006 was used for this study. The dataset comprised 24,276 activities relating to the volume crime offences of burglary dwelling, burglary in commercial buildings, TOMV, and TFMV. These four offence types were chosen for a number of reasons as they:

- Offer potential to examine a large number of crime scenes for forensic material.
- Are key offences for most police forces and also the U.K. Home Office (14).
- Are typically "recidivist" offences.

From February 2004, all dwelling and commercial burglaries and all TOMV offences that were notified to Northamptonshire Police were visited by a CSE. This attendance policy was intended to exclude any artificial "screening" of offences meaning that all possible crime scenes were attended (resource availability permitting) and the data collected was as complete as possible. However, crime scenes prior to this time were screened by staff in an Incident Management Unit to ascertain the value of a forensic examination. This screening took place for all TFMV offences in the entire study period. This has the consequence of attending only those crime scenes that "an informed assessment process" believes has the best opportunity of recovering forensics.

The Northamptonshire Police forensic data was enhanced by combining it with IMD data, described as follows. Northamptonshire Police have 109 geographical Beat areas, a beat being a defined area with dedicated police resources allocated to it. The 109 beats are aligned with Local Authority Wards (political areas) each of which can have more than one LSOA. The average of LSOA scores and ranks within each beat was obtained, resulting in a table of Beat code, Ward code, Average IMD score, and Average IMD rank. Using a *K*-Means clustering algorithm (15), eight bands were created giving a good representation of the deprivation of the beat and hence crime scenes which are attended by CSEs in each beat. Band 1 is the most deprived area, whereas Band 8 is the least deprived. Table 1 identifies the number of crimes in each band and the minimum and maximum IMD score located within each band.

Figure 1 displays the trend line illustrating the difference between the percentage of crimes within each IMD band. The chart shows that for TOMV offences and burglary dwelling (BDwell) the percentage of crimes increase as the index increases and the opposite for the other crime types. Using an independent sample *t*-test, at the 95% confidence level, the percentage of crimes within each band is not statistically significant meaning that the percentage of crime within each IMD band is evenly distributed.

Method

The work within this study was undertaken within a data mining environment. Data mining encompasses a range of techniques each designed to interpret data to provide additional information to assist in its understanding. This reveals insights into a range of functions in an organization, which can assist in the areas of decision support, prediction, resource handling, forecasting, and estimation. The

TABLE 1—*Number of crimes within each IMD band.*

IMD band	Number of offences	Min IMD score	Max IMD score
1	5053	2.39	9.63
2	4398	10.16	17.05
3	2565	20.33	23.07
4	2124	23.93	25.78
5	1993	26.12	27.1
6	1884	29.21	29.98
7	2080	32.12	35.12
8	1620	39.24	43.86

IMD, Index of Multiple Deprivation.

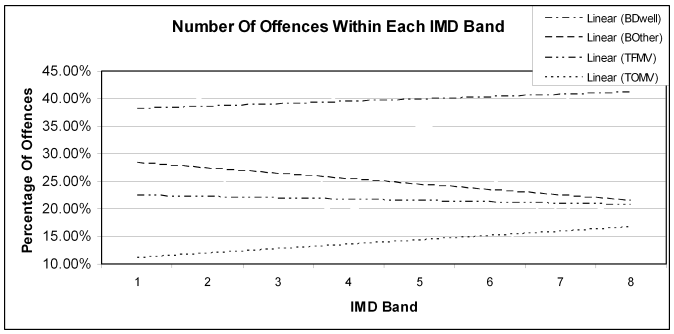

FIG. 1—*Percentage of offences, by offence type, within each IMD band. BDwell, burglary dwelling; BOther, burglary in commercial premises; TOMV, theft of motor vehicle; TFMV, theft from motor vehicle.*

techniques trawl systems which often contain voluminous amounts of data items which have limited value and are difficult to examine in their original format, finding hidden information producing benefits to the organization.

Data mining embraces a range of techniques such as neural networks, statistics, rule induction, data visualization etc., examining data within current computer systems with a view to identifying operational issues by uncovering useful, previously unknown information (16). Today computers are pervasive in all areas of organizational activities which has enabled the recording of all workplace operations making it possible not only to deal with record keeping and information for performance management but also, via the analysis of those operations, to improve operational performance.

The majority of organizations record and store large amounts of data in a variety of databases and often there is restricted access to these data. In order to glean information, a user would ask a specific range of questions, for example; who is the most prolific offender? The ironic reality of the information age is that we are overwhelmed with information. Pertinent research questions are not articulated because the task of comprehending the full dimensions of an information system is too large to sensibly work through the myriad of possibilities. Data mining can provide methods to identify the questions to be asked in order to gain a greater understanding of the data and analytical processes (17).

By applying the techniques identified above, organizations have utilized their data relating to tasks such as identifying customers' purchasing behavior, financial trends, anticipating aspects of demand, reducing and detecting fraud, etc. For example, by employing such techniques J. Sainsbury is said to have saved £500,000 a year by analyzing patterns of shoplifting within its stores (18).

Although the practice of mining data has been performed for a number of years, the term data mining has only recently received credibility within the business community. The Gartner Group analysts' (19) estimate that within targeted marketing, the number of companies using data mining will increase from the current level of 5–80% within 10 years. Currently, little use has been made of data mining techniques within policing as the majority of police computer systems do not utilize such technology. Early attempts to introduce data mining into policing concentrated on visualization techniques and expert systems (20,21) with varying degrees of success but have never transferred into main stream policing. There is, however, great scope for these techniques to be used (22,23).

Insightful Miner

This work was undertaken using the commercially available data mining workbench software tool, Insightful Miner. This tool uses a graphical user interface to retrieve, manipulate, model, and present data (Fig. 2). This is accomplished by placing nodes onto a worksheet to build the required business process and passing the data through that process. Therefore the importance of data mining to this process revolves around the working environment and methodology. Within a single software package, it was possible to:

- Retrieve the data;
- Clean, manipulate, and combine data sources;
- Model the data; and
- Present the results.

Results

The aim of this study was to examine the effects of deprivation on the time spent at the crime scene by CSEs and their ability to recover fingerprints and DNA. Northamptonshire Police's policy is to deploy their CSEs from a central point even though there are two geographical centers where they are stationed. This deployment policy has shown that none of the CSEs "cherry pick" crime scenes in geographical areas; therefore, their workload is distributed across all of the deprivation bands.

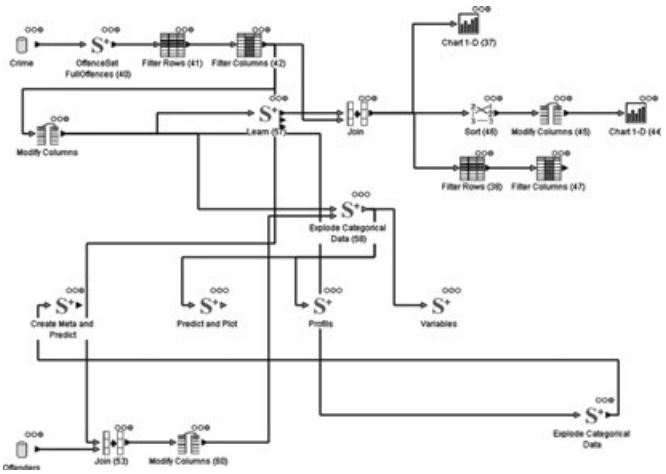

FIG. 2—*Insightful miner data mining workbench tool.*

Time at the Scene

The hypothesis to be tested in this section was: "The deprivation index of the crime scene has no effect on the time spent at the scene by CSEs." Figure 3 illustrates the average time spent at the crime scene by offence and IMD band. The average time within each band varied by no more than 3 min and a regression model confirms that the null hypothesis is true. That is, the deprivation index has no effect on time spent by CSEs at the crime scene.

A further regression model was built to assess the relationship between the time spent at the scene by CSEs and each crime type and IMD band, the null hypothesis being: "The Offence and IMD band have no impact on the time each CSE spends at the crime scene." At the 95% confidence level the null hypothesis was upheld meaning that neither the IMD band nor the crime

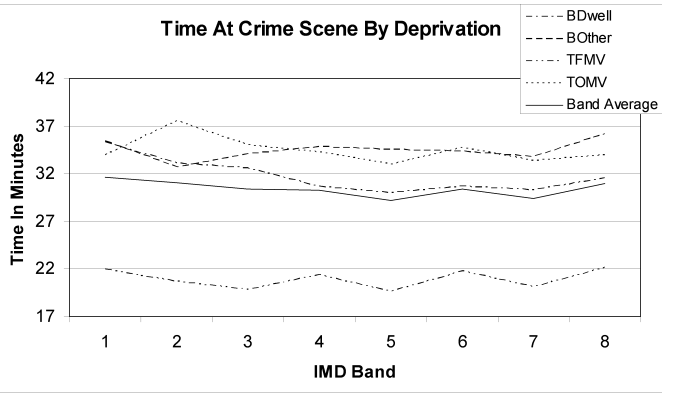

FIG. 3—*Time spent at the crime scene by offence and IMD band. BDwell, burglary dwelling; BOther, burglary in commercial premises; TOMV, theft of motor vehicle; TFMV, theft from motor vehicle.*

TABLE 2—*Average total number of fingerprints recovered by offence and IMD band.*

IMD Band	BDwell	BOther	TFMV	TOMV	Band Avg
1	0.51	0.40	0.38	0.46	0.44
2	0.53	0.38	0.39	0.54	0.46
3	0.51	0.43	0.38	0.53	0.46
4	0.50	0.36	0.42	0.53	0.45
5	0.53	0.38	0.46	0.51	0.47
6	0.48	0.47	0.46	0.54	0.49
7	0.53	0.40	0.40	0.57	0.48
8	0.55	0.45	0.44	0.62	0.52
Offence Avg	0.52	0.41	0.42	0.54	0.47

IMD, Index of Multiple Deprivation; TFMV, theft from motor vehicle; TOMV, theft of motor vehicle; BDwell, burglary dwelling; BOther, burglary in commercial premises; Avg, average.

type has any effect on the time that CSEs spent at the scene of a crime.

Fingerprint Recovery

The hypothesis to be tested in this section was: "The deprivation index of the crime scene and the crime type has no effect on the ability of CSEs to recover fingerprints."

Table 2 illustrates the amount of fingerprints recovered at the crime scene by offence and IMD band, and Fig. 4 illustrates the trend line. As the geographical areas improve in terms of less deprivation (deprivation index rises), the chart illustrates that there is a trend for CSEs to recover more fingerprints from the crime scene.

A regression model was built to test the upward trend statistically. Even though there is evidence of an upward trend, at the 95% confidence level the null hypothesis was upheld meaning that neither the IMD band nor the crime type has any effect on the ability of a CSE to recover fingerprints from a crime scene. The upward trend is not statistically significant.

DNA Recovery

The hypothesis to be tested in this section was: "The deprivation index of the crime scene and the crime type has no effect on the ability of CSEs to recover DNA." Table 3 illustrates the amount of DNA recovered at the crime scene by offence and IMD band and Fig. 5 illustrates the trend line. As the geographical areas improve (IMD band increases), this chart also illustrates that there is a trend for CSEs to recover more DNA from the crime scene.

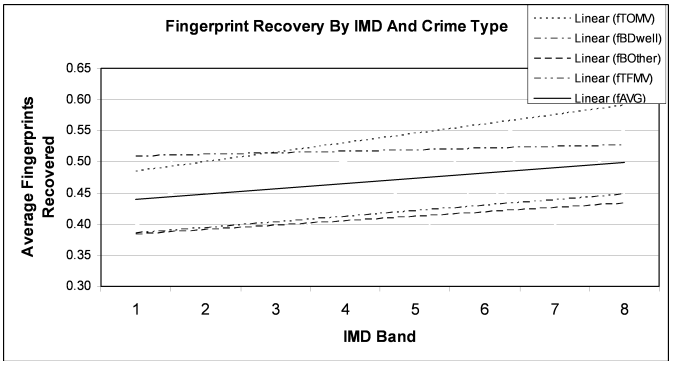

FIG. 4—*Trend of fingerprint recovery by offence and IMD band (the prefix "f" to the crime type indicates "fingerprints"). fBDwell, burglary dwelling; fBOther, burglary in commercial premises; fTOMV, theft of motor vehicle; fTFMV, theft from motor vehicle; fAvg, average.*

TABLE 3—*Average total number of DNA recovered by offence and IMD band.*

IMD Band	BDwell	BOther	TFMV	TOMV	DNA Avg
1	0.07	0.07	0.04	0.14	0.08
2	0.07	0.06	0.05	0.17	0.09
3	0.07	0.09	0.04	0.17	0.09
4	0.07	0.05	0.06	0.16	0.09
5	0.05	0.08	0.05	0.15	0.08
6	0.06	0.04	0.04	0.15	0.07
7	0.09	0.12	0.08	0.21	0.13
8	0.08	0.06	0.06	0.21	0.10
Offence Avg	0.07	0.07	0.05	0.17	0.09

IMD, Index of Multiple Deprivation; TFMV, theft from motor vehicle; TOMV, theft of motor vehicle; BDwell, burglary dwelling; BOther, burglary in commercial premises; Avg, average.

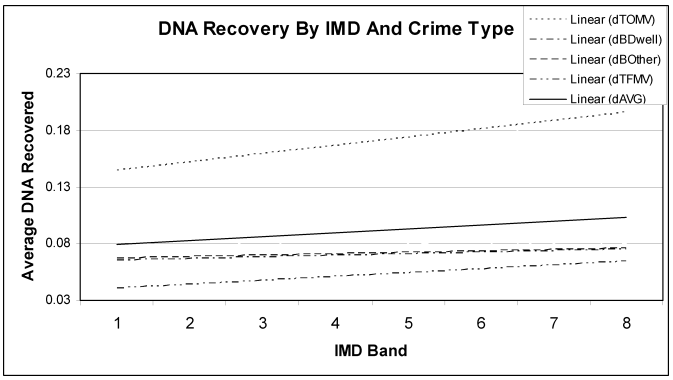

FIG. 5—*Trend of DNA recovery by offence and IMD band (the prefix "d" to the crime type indicates "DNA"). dBDwell, burglary dwelling; dBOther, burglary in commercial premises; dTOMV, theft of motor vehicle; dTFMV, theft from motor vehicle; dAvg, average.*

A regression model was again built to test the upward trend statistically. In this instance, the model results rejects the null hypothesis meaning that the deprivation index of the crime scene does have a bearing the ability of CSEs in recovering DNA at specific crime types.

From Figs. 4 and 5 it can be seen that the percentage of scenes examined where fingerprints were recovered is much greater than where DNA was recovered. This is true for all the crime types considered in this study and is also reflected nationally across all U.K. police forces (3).

Discussion

The aim of this study was to ascertain whether the service provided by CSEs varies depending on the deprivation index of the crime scene location, the service provided relating to the time spent at the crime scene and the ability to recover DNA and fingerprint material. The general perception of CSEs and supervisors is that more time is spent and more forensics are recovered as the index increases (deprivation decreases).

The results contradict the CSEs' perception; the deprivation index of the crime scene has no bearing on the time that they spend investigating the scene. This equates to a consistent level of service, expertise, and professionalism being offered to those victims from poorer inner city areas and to those who live in more affluent areas.

The recovery of fingerprints is again contrary to the CSEs' perception, especially for burglary dwelling offences, where they

perceive that significantly more fingerprints are recovered as the index increases. The trend chart illustrates that although there is a slight increase in recovery as the index increases this is not statistically significant. Again, this reinforces the concept of a consistent level of service. The recovery of DNA, however, is different. The results show that it is statistically significant that more DNA is recovered as the index increases. This could be that, as the index increases (deprivation decreases), victims are more forensically aware and are, therefore, more able to articulate to the CSEs which items from the scene may be of importance in the subsequent investigation. This means that, although more DNA is recovered, the service afforded to the victim still remains consistent.

Further work to be considered is:

Thoroughly examine the geographical breakdown of criminality within Northamptonshire and vary the IMD bands accordingly. Repeat the process for varying configurations of IMD banding.

Although the recovery rate is important, the priority is to obtain identification from the recovery process. The work completed above should be extended to those forensic samples that have resulted in identification.

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References

1. Her Majesty's Inspectorate of Constabulary. Under the microscope. London: Association of Chief Police Officers (ACPO), 2000.
2. Her Majesty's Inspectorate of Constabulary. Under the microscope refocused. London: Association of Chief Police Officers (ACPO), 2002.
3. Police Standards Unit. Forensic performance monitors. London: Home Office, 2005.
4. Webb B, Smith C, Brock A, Townsley M. DNA fast-tracking. In: Smith MJ, Tilley N, editors. Crime science: new approaches to preventing and detecting crime. England: Willan, 2005;167–90.
5. Bond JW. The value of DNA evidence in detecting crime. J Forensic Sci 2007;52(1):128–36.
6. Association of Chief Police Officers and Forensic Science Service. Using forensic science effectively. London: Association of Chief Police Officers (ACPO), 1996.
7. Tilley N, Ford A. Forensic science and criminal investigation. Crime detection and prevention paper 73. London: Home Office, 1996.
8. Williams SR. The management of crime scene examination in relation to the investigation of burglary and vehicle crime. London: Home Office, 2004.
9. Bond JW. Maximising the opportunities to detect domestic burglary with DNA and fingerprints. IJPSM 2007;9(3):287–98.
10. http://www.communities.gov.uk/index.asp
11. http://www.neighbourhood.statistics.gov.uk/dissemination/Info
12. Brantingham PJ, Brantingham PL. Environmental criminology, 2nd edn. Illinois: Waveland Press, 1991.
13. Saulsbury B, Hibberd M, Irving B. Using physical evidence. London: The Police Foundation, 1994.
14. Home Office. National policing plan 2005–2008. London: Home Office, 2004.
15. Hartigan JA, Wong MA. A k-means clustering algorithm. Appl Stat 1979;18:100–8.
16. Adriaans P, Zantinge D. Data mining. New York: Addison-Wesley, 1996.
17. http://www.dmreview.com/editorial/newsletter_more.cfm?nl=bireport
18. Brown AJ. Mine, all mine. Computing 1996;10:46–52.
19. http://www.sas.com/software/data_mining
20. House JC. Towards a practical application of offender profiling in the RNC's Criminal Suspect Prioritization System. In: Jackson JL, Bekerian DA, editors. The personality paradox in offender profiling; offender profiling: theory, research and practice. Chichester, England: Wiley, 1998;177–90.
21. Haughton E. Digging for gold. Computing 1993;20:20–1.
22. McCue C, Stone ES, Gooch TP. Data mining and value-added analysis. FBI Law Enforcement Bulletin 2003;72:1–5.
23. Mena J. Investigative data mining for security and criminal detection. Burlington, MA: Elsevier Science, 2003.

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