Institution: University of Birmingham		
Unit of Assessment: 4 – Psychology, Psychiatry and Neuroscience		
Title of case study: Enhancing the use of crime linkage as an investigative tool and its role in law		
Period when the underpinning research was undertaken: January 2010–December 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
Professor Jessica Woodhams	Senior Lecturer, Reader and then Professor in Forensic Psychology	January 2010–current
Dr Kari Davies	Research Assistant/Fellow	September 2013–current
Period when the claimed impact occurred: November 2013–December 2020		
Is this case study continued from a case study submitted in 2014? No		

1. Summary of the impact

UoB has improved confidence in linking crimes by using data on consistent crime scene behaviour by individual perpetrators. This has resulted in police forces **globally** changing **policies and practices** and **significantly investing in personnel, training, and software**. Innovative new practices, such as the use of UK Automatic Number Plate Recognition alongside crime linkage data, are also being tested (e.g., in serious sexual crime investigation). Researchers have also highlighted the limitations of crime linkage, presenting expert evidence-based findings to the Scottish Court of Appeal, safeguarding its use by **setting a legal principle** to prevent the inappropriate application of the approach.

2. Underpinning research

Crime linkage is the process of linking 2 or more crimes together, based on the underlying principles that a perpetrator's behaviour will be both consistent and distinctive [R1]. Woodhams has developed the science underpinning use of crime linkage, with a particular focus on serious sexual offences. She has used **established benchmarks to assess the reliability of the underlying principles** [R1] which has led to significant advances in crime linkage research. These include conducting the **most robust studies to date with the largest, most representative, sample of sexual offences** [R2], conducting the only studies of unsolved linked series [R1–R3], and making detailed studies of the practice of crime linkage [R4, R5].

Her team's research has shown that across a range of crime types (e.g., rape, burglary, robbery), **offenders are sufficiently consistent and distinctive in their behaviour for a series of crimes from the same perpetrator to be identified with a high degree of accuracy** [e.g., R1–R3]. These positive findings have resulted in validating the use of linkage as part of the toolkit police can use. However, it has also been shown that some offenders are characterised by inconsistent and/or indistinct behaviour [R2, R3]. In these particular cases, erroneous links between crimes could be made (both human and by algorithm), that could have significant investigative and legal ramifications [R2]. In particular, Woodhams has shown that **unapprehended offenders are less consistent and less distinctive in their crime scene behaviour than apprehended offenders** [R2]. This is crucial, curbing over-confidence in the methods, because crime linkage is often applied in order to identify unapprehended offenders.

Woodhams founded, and leads, the **Crime Linkage International Network** (C-LINK), a collaboration of academics and police force practitioners now spanning 11 countries. The network was initiated with contacts interested and experienced in evidence-based forensic psychology and is expanding through mutual connections to form a key route for international knowledge exchange, dissemination, and impact.

C-LINK has conducted the most robust investigation of the relative value of different statistical algorithms for modelling offender consistency and distinctiveness, analysing 3,364 sexual offences [R3]. Based on this, and informed by research on crime analyst decision-making [R4], they have identified the algorithms with the potential as decision-support tools to automate parts of the linking process [R2]. For the first time, Woodhams and Davies mapped the decision-making processes in two jurisdictions (Belgium and the UK) [R4]. In doing so, they identified how analysts incorporate academic research into decision-making.

The strength of crime linkage (whether automated or not) depends on the data. Many countries use the Violent Crime Linkage Analysis System (ViCLAS) data management tool. However, how evidential data is coded into this system varies between North America and Europe, with implications for data reliability and crime linkage results. Davies and Woodhams assessed the reliability of coding of sexual offences in Belgium [R5] and Switzerland (ongoing) and, in Belgium, demonstrated that for some behaviours it did not reach acceptable standards of inter-rater reliability. They were able to **make recommendations for unifying coding, to increase reliability**.

Finally, as an example of the breadth of evidence used in linking crimes, Woodhams proposed the novel use of Automatic Number Plate Recognition (ANPR) data in the detection of serial sexual offenders; ANPR data is not routinely used or retained for this purpose. Using the largest UK dataset of serial sex offenders, she has charted geographical and temporal patterns of offending and demonstrated how consistent preservation of ANPR data across the UK would enhance police ability to link crimes and detect perpetrators [R6].

Overall, Woodhams and her team have driven the development of crime linkage as scientific practice based on sound principles, while also constraining its inappropriate use. The Key findings [KFs] of the research can be summarised as:

KF1: The utility of crime linkage to help identify suspects has been established [R1, R3];

KF2: Linkage evidence alone is not sufficiently reliable to establish guilt [R2];

KF3: Weak points in current crime analysis practice have been identified [R4, R5];

KF4: Algorithms to automate parts of the linking process have been identified [R3];

KF5: Data sources not routinely considered for use in crime linkage can be used beneficially [R5, R6].

3. References to the research

R1: Woodhams, J., & Labuschagne, G.N. (2012). A test of crime linkage principles with solved and unsolved serial rapes. *Journal of Police and Criminal Psychology*, 27: 85–98. DOI: 10.1007/s11896-011-9091-1

This paper has 53 citations and an FWCI of 7.06 (Scopus, 25th February 2021)

R2: Woodhams, J., Tonkin, M., Burrell, A., *et al*. (2019). Linking serial sexual offences: Moving towards an ecologically valid test of the principles of crime linkage. *Legal and Criminological Psychology*, 24: 123–140. DOI: 10.1111/lcrp.12144

R3: Tonkin, M., Pakkanen, T., Siren, J., Bennell, C., Woodhams, J., *et al*. (2017). Using offender crime scene behaviour to link stranger sexual assaults: A comparison of three statistical approaches. *Journal of Criminal Justice*, 50: 19–28. DOI: 10.1016/j.jcrimjus.2017.04.002

This output has 11 citations (Scopus, 25th February 2021). It has also been selected as one of the UoA outputs for REF2021.

R4: Davies, K., Alrajeh, D., & Woodhams, J. (2017). An investigation into the process of comparative case analysis by analysts working in the Serious Crime Analysis Section in the United Kingdom.

A research report prepared for the Serious Crime Analysis Section of the National Crime Agency.

R5: Davies, K., Imre, H. & Woodhams, J. (2018). A test of the inter-rater reliability of the coding of the Violent Crime Linkage Analysis System (ViCLAS).

This internal research report was prepared for the Zeden-Analyse-Moeurs (ZAM) unit, Belgium.

R6: Woodhams, J., & Davies, K. (2019). The ANPR Data Retention and Preservation Project: Final Report.

This internal research report was prepared for the Home Office, UK.

Grants and Research Contracts to Woodhams:

Evaluation of crime linkage processes in Switzerland. Bern Cantonal Police. 01.06.19–01.01.21, £57,182.

Automatic Number Plate Recognition (ANPR) Data Retention Project. National Police Chiefs Council, 01.07.16–31.05.19, £5,000.

C-LINK (Crime Linkage International NetworK), Detecting stranger sex offenders, Leverhulme Trust, 01.05.13–31.03.16, £79,456.

4. Details of the impact

International impacts on the use of crime linkage by practitioners

Increased confidence in the reliability of linkage analysis, as **used by practitioners internationally as an investigative method** [KF1, KF4], has been provided from research by Woodhams, Davies and the Crime Linkage International NetworK (C-LINK) [R1–R3]. This impact is evidenced by the sustained/increased use of crime linkage in countries across the world. For example:

- In the UK, the research has justified the continued use of crime linkage, where it is used in an average of 500 reports for the Serious Crime Analysis Section per year [E1]. Woodhams' research [KF1, KF3] has also been used to resist financially driven changes to current processes which would have seen a simplification of the UK Violent Crime Linkage Analysis System (ViCLAS) but reduced its value as a crime linkage tool — a decision that has "directly impacted upon all 31,962 cases currently held on the SCAS database." [E1]
- In Sweden, Woodhams' research has been used to define **best practice** by establishing a new national unit as well as investment in the national ViCLAS crime linkage database for sexually violent crime. The Detective Superintendent leading the Investigative Analysis & Offender Profiling Group stated:

  > Research […] by Professor Woodhams and the Crime Linkage International NetworK (C- LINK) that she leads, was an important part of this decision taken by our senior management. [...] This new unit is a significant investment by the Swedish Police Authority. [E2]

- In Belgium, increased confidence has led to new ways of working in the national crime linkage specialist unit (Zeden-Analyse-Moeurs: ZAM) pertaining to coding practice, analysis and data control [E3; KF3]. In particular, **new legislation**, communicated by the Minister of Justice, Minister of Security and the Interior, and the College of Attorney means that all cases of sexual assault are now reported to the unit:

  > The results of your project, based on the efficiency and therefore the reliability of ZAM's work, have supported this legislative change, changes for which we have been fighting for years. [E3]

- In New Zealand, a new operational crime linkage tool, "which is fundamentally based on the research of Woodhams and colleagues" [E4; KF4], has been developed and "has influenced crime linkage analyses in cases involving serial burglary, car theft, sex offending, and robbery […] this has resulted in successful prosecutions and the

> recovery of stolen property, thereby providing victims with greater access to justice." [E4]

Informing best practice use of crime linkage through training and innovation

As a result of these changes in practice, evidence from University of Birmingham research is now used for **CPD training** of crime analysts. For example:

- In the UK, R4 is used as a CPD tool by the Serious Crime Analysis Section [E1].
- In Belgium, the work conducted by C-LINK [e.g. KF3] is used "in the training of police officers at all levels […] as well as to the serious crime inspectors at the Centre for the Management of Sexual Violence." [E3]
- In New Zealand, crime linkage training occurs "at a local, regional and national level that is underpinned by the research of Professor Woodhams and colleagues' [KF4] reaching 5 out of 12 police districts [E4].

Innovative aspects of Woodhams' research are also being used in the UK police service, such as ANPR in crime linkage [KF5]. In February 2020, following a successful trial, **best practice guidance** to preserve ANPR data around stranger sex offences was sent to each of the 43 police force ANPR units. The Home Office Head of Innovation, Law Enforcement, states:

> One of the areas explored, as part of a series of innovative activities, was a project to maximise the value of Automatic Number Plate Recognition (ANPR) data. […] The police interrogation of ANPR data, as a result of the research by Woodhams, led to the identification of one or more new vehicles of interest in 35 of 50 unsolved stranger rape series in the UK. […] This was a highly innovative piece of work, which has since been cited at high level meetings within the Home Office as an example of how academia, policing and Government can work together to keep citizens safe and the country secure. It has specifically informed the decision to invest further. [E5]

Informing the use of crime linkage in legal practice

In parallel with the increase in crime linkage practices, Woodhams' research [KF1 and KF2] has also been used to highlight that crime linkage alone is not sufficiently reliable for evidential use in court and that its usage should be limited to investigative practices.

In 2014, the Scottish Appeal Court ruled on the admissibility of crime linkage evidence using Woodhams' research [KF1 and KF2] as **the basis to set a legal principle** in an appeal case. The defendant's appeal rested on analysis that suggested a murder was linked behaviourally to other murders in Scotland, which had occurred after the defendant's incarceration.

Woodhams provided pivotal expert testimony to the effect that — whilst it represented a useful investigative tool [KF1] — linkage evidence alone was not sufficiently reliable to establish serial crime [KF2]. Her testimony proved definitive [E6] and according to the Procurator Fiscal for the Crown it avoided:

> what would have been one of the largest miscarriages of justice in Scottish history […] this case has become legal precedent for how reliability of evidence is assessed by the courts in Scotland. [E7]

The legal principle is now established and reported in *Renton and Brown's Criminal Procedure* — the legal text of Scottish criminal law [E8] — and in the Forensic Science Regulator's *Legal Obligations* publication [E9]. The latter document was quoted extensively by a senior legal commentator in her recommendation to the Scottish Law Commission that the test for reliability in this case could form the basis of a wider test on the admissibility of expert evidence [E10].

5. Sources to corroborate the impact

E1. Testimonial from the Serious Crime Analysis Section of the National Crime Agency which explains how the research has safeguarded the future of the unit, and informed decisions not to reduce the variables on the UK's ViCLAS database. [Dated 4 June 2020]

E2. Testimonial from the Swedish National Operations Department, Investigative Analysis & Offender Profiling Group confirming how the research informed Government decisions to reinstate the ViCLAS database in Sweden and set up a new unit of five analysts. [Dated 17 February 2020]

E3. Email Testimonial from the Belgium ViCLAS unit which explains how the research has resulted in the establishment of new legislation to support crime linkage on a national basis in Belgium (originally provided in French, translation provided) [Dated 6 January 2021]

E4. Testimonial from the New Zealand Police confirming the adoption of statistical algorithms in the linking of crimes in New Zealand. [Dated 29 January 2021]

E5. Testimonial from the Home Office as to the impact of the ANPR project.

E6. *THOMAS ROSS YOUNG V. HER MAJESTY'S ADVOCATE* [2013] Scot HC HCJAC 145. Appeal No: XC896/07 AND REFERENCE FROM THE SCCRC BY THOMAS ROSS YOUNG AGAINST HER MAJESTY'S ADVOCATE [2014] Scot HC HCJAC 113. Appeal No: XC896/07

A description of the expert evidence given by Woodhams to the Scottish Appeal Court in making references to her research as well as her expertise; the Court's judgement of evidence admissibility; and the subsequent legal principle regarding reliability are in this record of the original hearing in November 2013 and in the subsequent 2014 hearing.

E7. Testimony from the Procurator Fiscal for the Crown in the Thomas Ross Young Appeal as to the significance of the case. [Dated 24 February 2021]

E8. *Renton and Brown's Criminal Procedure (6th Ed.)*, Volume 1, Part VIII – Evidence, Chapter 24, Evidence, Miscellaneous Rules. Thomson Reuteurs.

This case has become legal precedent and is used to define how evidence should be assessed for its reliability is reported in *Renton and Brown's Criminal Procedure* (6th Ed.) which is *the* legal text for Scottish judges and lawyers. Footnote 1 refers to the evidence used in the HMA v. Young case.

E9. Forensic Science Regulator – Legal Obligations, FSR-I-400, Issue 6 (August 2018)

Evidence from Dr Woodhams and the appeal case itself is referred to in Issue 3, 4, and 6 (see paragraph 8.12 – Reliability; page 113).

E10. The Honourable Lady Scott's response to the Scottish Law Commission's consultation on topics for inclusion in its Ninth Programme of Law Reform (16th August 2014)

In Lady Scott's proposal for reform around admissibility and expert evidence in Scotland, she explains the decisions around reliability in HMA v. Young. On page 4, she refers to this case and the influence the submissions made in the case had on the Court's definition of reliability.