

Improving the explanatory content of analysis products using hypothesis testing

Dr Spencer Chainey

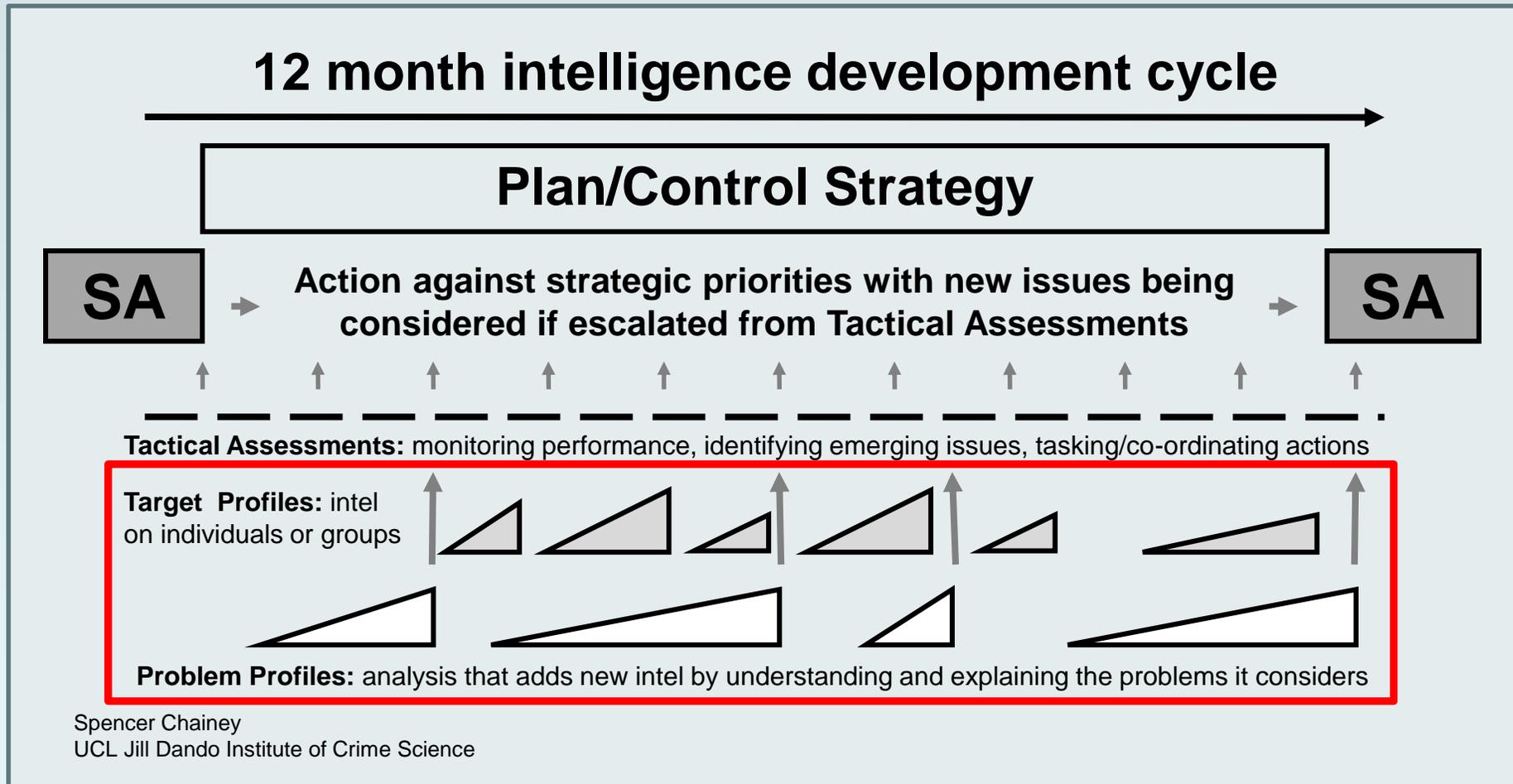
University College London Department of Security and Crime Science

**International Crime and Intelligence Analysis Conference
25-26 February 2016, Manchester (UK)**

Overview

- Analysis/intelligence products
- The role of analysis
- Using hypothesis testing to move from the descriptive to the explanatory
 - Problem profile structure
 - Examples: robbery, mobile phone theft, domestic burglary
- Practical considerations
- Resources

The UK intelligence production process



SA: Strategic assessment: identifying priorities for strategic action

What should a good
analysis product/report
look like?

What should a good analysis product look like?

A survey of police managers and analysts

- Concise
- Clear
- Well structured
- Explain why the problem exists
- Be interesting
- Use good quality data
- Should include recommendations
- Well presented, with good use of graphs, maps and pictures
- Provides more than just statistics
- Draws from the evidence-base

What are the main reasons that prevent the production of good analysis products?

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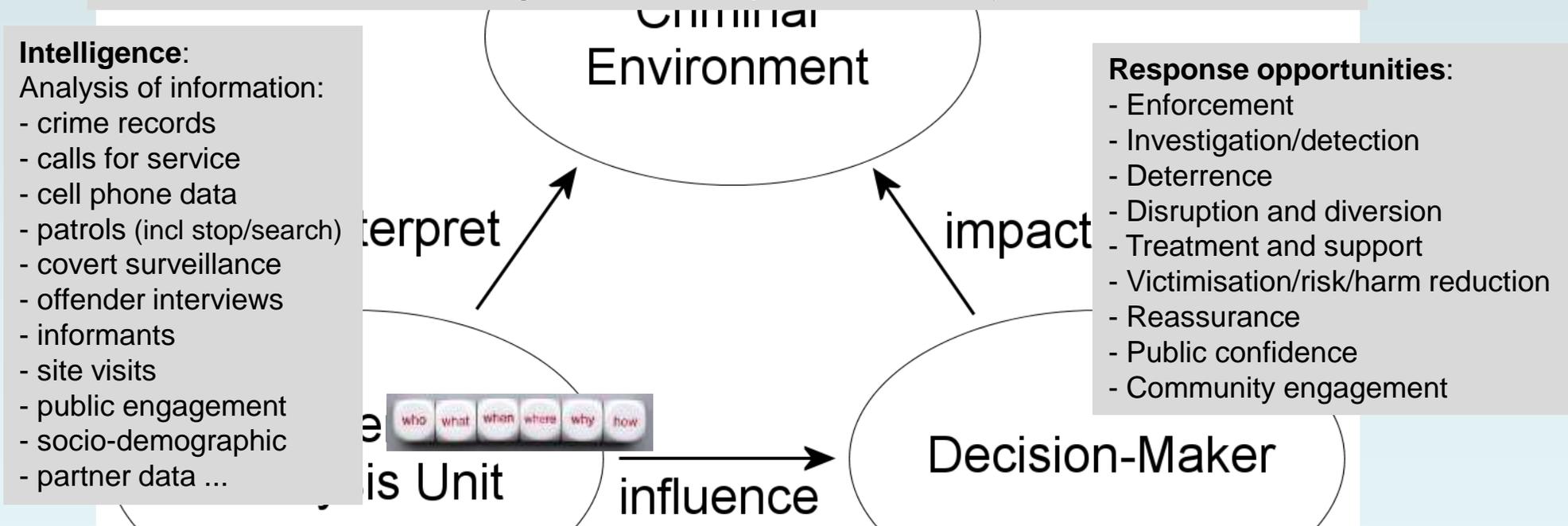
A survey of police managers and analysts

- Poor terms of reference on what is required
- Lack of time to do good analysis
- Managers want the analysis to justify what they plan to do, rather than the analysis informing what they do
- Managers do not know what analysts can do
- Poor quality data
- Data not available
- Lack of feedback on the analysis produced
- IT systems are poor
- Managers do not really know what they want!

The intelligence-led production process

And the role of analysts and decision-makers

General, descriptive intelligence profiles, with very little that explain specifically why the problem exists; fail to help identify what is likely to have an impact
 How can we change this and improve the analytical function?



- Intelligence:**
 Analysis of information:
- crime records
 - calls for service
 - cell phone data
 - patrols (incl stop/search)
 - covert surveillance
 - offender interviews
 - informants
 - site visits
 - public engagement
 - socio-demographic
 - partner data ...

- Response opportunities:**
- Enforcement
 - Investigation/detection
 - Deterrence
 - Disruption and diversion
 - Treatment and support
 - Victimisation/risk/harm reduction
 - Reassurance
 - Public confidence
 - Community engagement

Intelligence product: fundamental component to intel-led policing, facilitating decision-making framework

Improving the explanatory content of intelligence analysis using hypothesis testing (the scientific method)

- Hypothesis: a true (or false) statement that provides a plausible reason to explain the problem
 - Testing it results in coming to some conclusions



What's a hypothesis?

A word cloud centered around the word "Hypothesis". The word "Hypothesis" is the largest and most prominent, written in a large, bold, brown font. Other words are smaller and arranged around it, including "Theory", "Explanation", "Opinion", "Reason", "Belief", "Idea", and "Hunch".

Theory
Hypothesis
Explanation
Hunch
Reason **Opinion** **Belief**
Idea

Improving the explanatory content of analysis products using hypothesis testing

- Frame direction and content of analysis using hypothesis testing

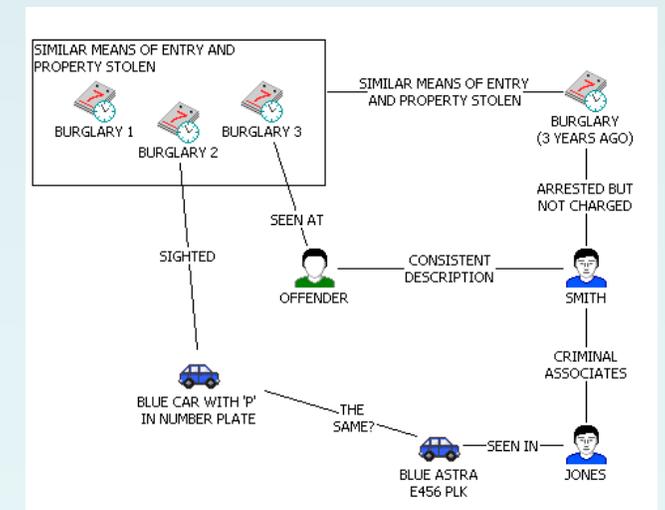
Hypothesis:

- A true (or false) statement that provides a plausible reason to explain the problem - results in coming to some conclusions
- Identifies the data that are required and analysis to conduct
- Helps identify key intelligence gaps

- Focus is on examining Why

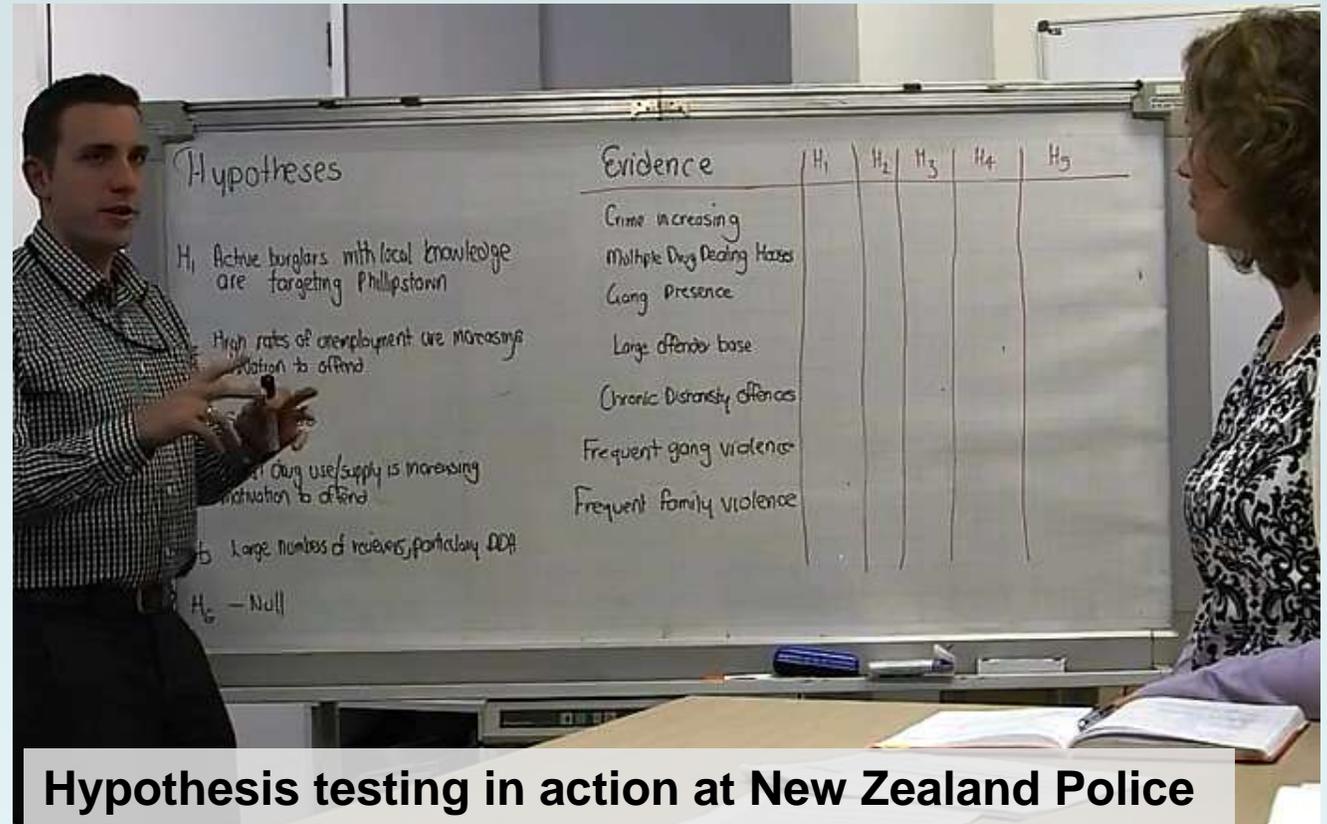


- Using whichever WWWW (4Ws1H) are most suitable for the hypotheses that are being tested



Improving the explanatory content of analysis products using hypothesis testing

- Injecting scientific method into SA of SARA
- Key stakeholders of the problem should be the ones who come up with hypotheses
 - Helps improve commissioning/dialog on what is required



Hypothesis testing in action at New Zealand Police

- Makes it easier to identify how to respond
 - Hypothesis testing helps explain why there is a problem
 - Identify the tactics and strategies that counter these explanations



Injecting hypothesis testing into Scanning-Analysis

Reducing gang-related drug crime in Phillipstown, New Zealand

POP NZ Police Phillipstown 5mins

Hypotheses

~~H₁ Active burglars with local knowledge are targeting Phillipstown~~

~~H₂ High rates of unemployment are increasing motivation to offend~~

~~H₃ Status quo~~

H₄ Local drug use/supply is increasing motivation to offend

~~H₅ - Null~~

Evidence

	H ₁	H ₂	H ₃	H ₄	H ₅
Crime increasing	✓	✓	✗	✓	✗
Multiple Drug Dealing Houses	-	-	✓	✓	✗
Gang Presence	-	-	✓	✓	✗
Large offender base	✓	✓	✓	✓	✗
Chronic Dishonesty offences	✓	-	✓	✓	✗
Frequent gang violence	✗	✗	-	✓	✗
Frequent family violence	✗	-	✓	✗	✗

Incorporating hypothesis testing into analysis

Analysis report structure

- Overview – clearly defining the problem and setting the scene
 - Key features about the problem e.g., scale of the problem, trends, who's involved?
Share overview with stakeholders, getting them to propose hypotheses
- Reasons for the problem
 - Hypotheses (3-5 max – unlikely you'll have capacity to do more)
- Analysis
 - Each section based on testing each hypothesis
- Conclusions/interpretation
 - Drawing together the results from the analysis
 - Explaining why the problem exists
 - Recognising that the problem is made of several different, unique qualities

Examples of hypotheses: street robbery in Town A

1. **The periodic increases in robbery are due to a large number of offences being committed by a small number of offenders**
2. Increases in robbery are an extension of bullying and imposition of power rather than for financial gain
3. The robbery increase is a reflection of an increase in community tensions between ethnic groups. This has resulted in an increase of groups of one ethnicity targeting lone or small groups of persons of a different ethnicity (e.g. white group on lone Asian male, Asian group on two white males)
4. **Increases in robbery have been caused by an increase in offences against taxi-drivers**

Street robbery in Town A

Concise, myth-busting analysis!

3.4. Hypothesis 4: Increases in robbery have been caused by an increase in offences against taxi-drivers

Over the last year, only 2% of robbery victims stated their occupation as a taxi-driver. Figure 19 shows the level of robbery victimisation against taxi-drivers compared to the trend in robbery between January 2011 to March 2012. This indicates that victimisation against taxi-drivers is not behind the recent increases in robbery.



Figure 19. Change in victimisation against taxi-drivers compared the total robbery trend.

Summary and interpretation

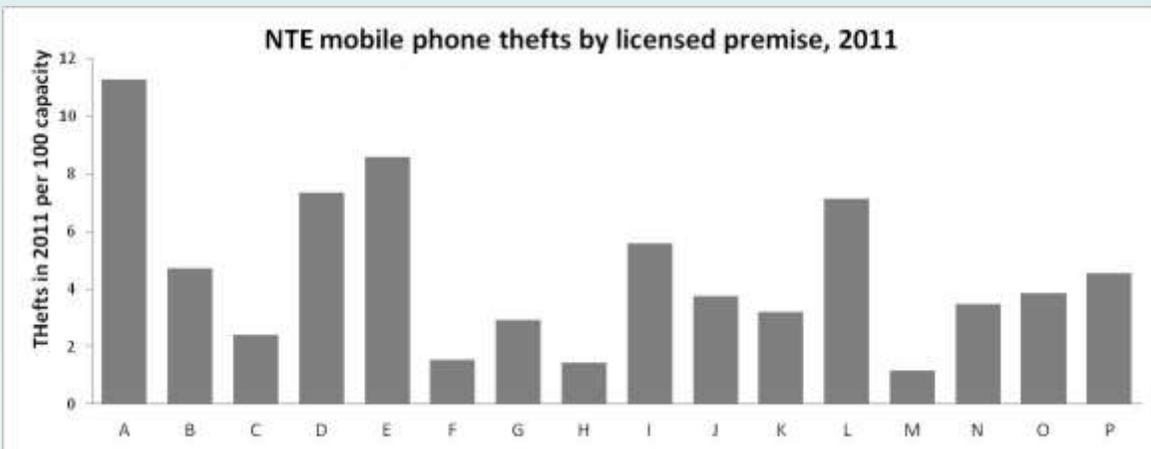
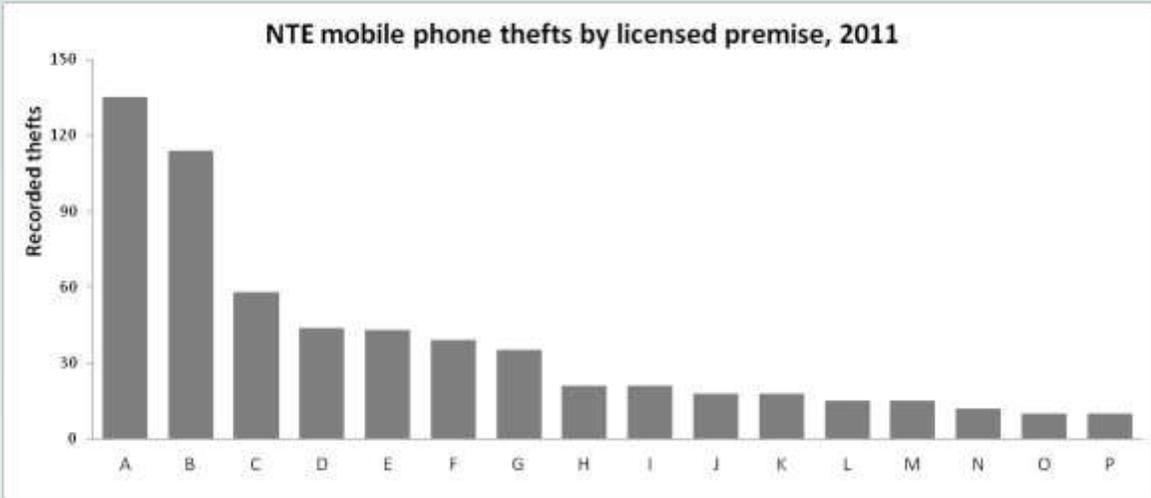
- Increases in robbery have not been caused by an increase in offences against taxi-drivers

Example: mobile phone theft in Birmingham

Hypotheses (1 of 2)

1. The increase in mobile phone theft has been driven by the theft of high value smartphones rather than other types
2. Young women (18-25), most of whom are students, have increasingly become victims of mobile phone thefts, particularly on Friday and Saturday nights
3. The increase in mobile phone thefts is being driven by organised criminality rather than offenders operating on their own
4. **A small number of licensed premises are responsible for the increase in mobile phone thefts during hours associated with the night-time economy**

A small number of licensed premises are responsible for the increase in mobile phone thefts during hours associated with the night-time economy (NTE)



- 396 licensed premises in Birmingham
- Seven licensed premises were responsible for 50% of all mobile phone theft and $\frac{3}{4}$ of entire increase
- **Response design implications?**

Summary

- A small number of licensed premises were responsible for both the largest share of NTE mobile phone theft and the increase in NTE mobile phone theft. The seven premises listed below were responsible for half of all NTE mobile phone thefts in 2011 and for three-quarters of the entire NTE- mobile phone theft increase across TownB.

	Proportion of mobile phone thefts 2011 (listed with volume)	Rank: thefts in 2011 per 100 capacity	Change OctDec2010 to OctDec11 (listed with volume change)	OctDec2010 to OctDec2011: % of increase attributable to LP
A	14% (135)	1	200% (32)	19%
B	12% (114)	5	156% (28)	16%
C	6% (58)	13	450% (18)	10%
G	3.5% (33)	12	467% (14)	8%
E	4.5% (43)	2	700% (14)	8%
I	2% (21)	4	1100% (11)	6%
D	5% (44)	3	500% (10)	6%

Example: Explaining the burglary increase in Oldham

Overview: domestic burglary in Oldham

- Nov 2010 - February 2011
 - 18% increase (91 more burglaries)
- Increase concentrated
 - Q2 Oldham East: 65%

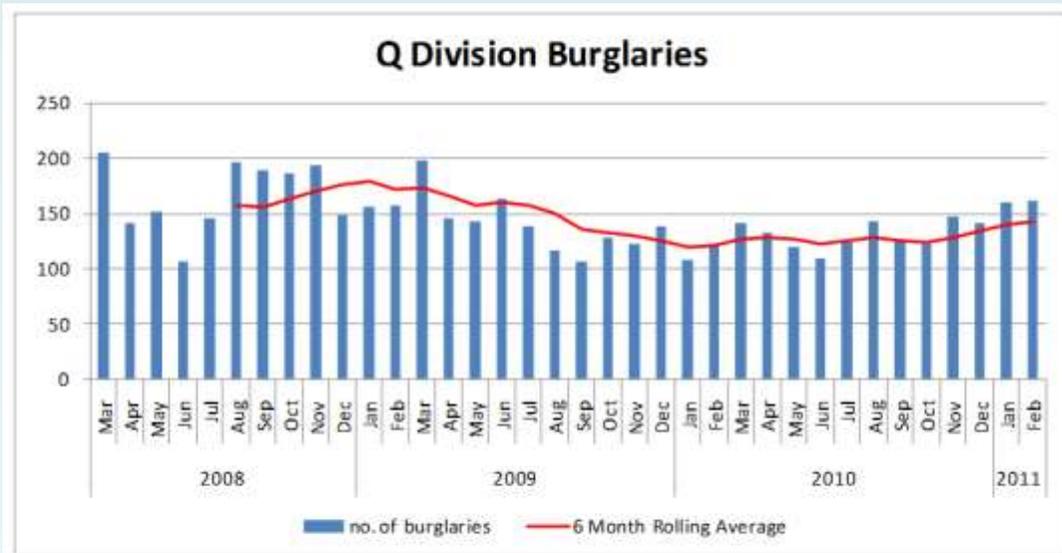


Figure 1. Oldham burglary dwelling trends – March 2008 – February 2011.

	Nov09- Feb10	Jul- Oct10	Nov10- Feb11	Change: Nov09 to Feb10 – same period prev year	Change: Nov09 to Feb10 - prev 4 mnths
Q1	125	142	147	↑18% 22	4% 5
Q2	71	81	134	↑89% 63	↑65% 53
Q3	71	76	90	↑27% 19	↑18% 14
Q4	81	70	89	↑10% 8	↑27% 19
Q5	86	103	80	↓7% -5	↓22% -23
Q6	58	43	66	↑14% 8	↑53% 23

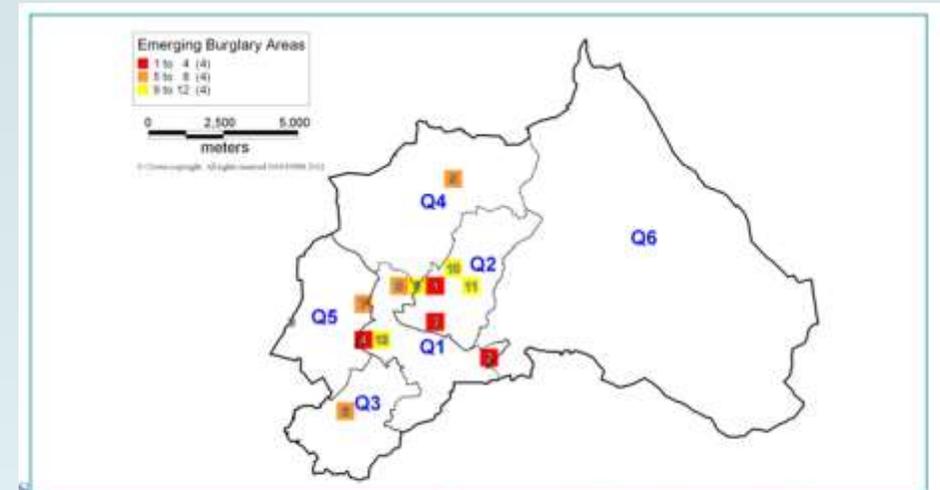
Example: Explaining the burglary increase in Oldham

Overview: domestic burglary in Oldham

- Emerging problem areas (Using Dispersion Calculator)
 - 12 out of 462 areas (grid cells) were mainly responsible for the increase



Why do you think we have had this increase in burglary in Oldham?



Locality of grid cell	Burglary dwelling Jul – Oct 2010	Burglary dwelling Nov 10 – Feb 11	Increase
1. West of Shaw Road, Q2	1	14	13
2. Holts Estate, Q1	4	15	11
3. Greengate Street, Q2	0	9	9
4. West of Block Lane, Q1	4	12	8
5. Small Brook Estate, Q5	3	10	7
6. Higher Memorial Park, Q3	9	15	6
7. Middleton Road, Q1	1	7	6
8. Mitchell Street, Q1	5	11	6
9. Oldham Edge, Q1 / Q2	9	15	6
10. Around Stoneleigh Park, Q2	2	8	6
11. Littlemoor Lane, Q2	9	15	6
12. Newport Street, Q1	2	7	5
Total	49	138	89

Figure 4. Areas in Oldham that have contributed most to the recent burglary dwelling increase, listed in rank order of their contribution.

Example: Explaining the burglary increase in Oldham

- **Hypothesis 1 (More Offenders):** The increase in burglary is attributable to an increase in burglary offenders living in these areas as a direct result of an increase in prison releases
- **Hypothesis 2 (Less Effective Cocooning):** The increase in burglary is attributable to a decrease in the effectiveness of “cocooning” in these areas, leading to a higher level of repeat and near-repeat victimisation
- **Hypothesis 3 (Targeting Jewellery):** The increase in burglary has been driven by an increase in gold jewellery thefts, particularly in Asian (Indian) neighbourhoods
- **Hypothesis 4 (Darker Evenings):** The increase in burglary is attributable to an increased opportunity for burglars to offend in the early evening due to the extended hours of darkness over the winter

Explaining the burglary increase in Oldham

Hypothesis 1 (More Offenders): The increase in burglary is attributable to an increase in burglary offenders living in these areas as a direct result of an increase in prison releases

- Prison releases
 - Increased by 52%. However:
 - Intensive supervision of ex-offenders via Spotlight (IOM)
 - Only one of these prisoner releases was linked to a BDW that was committed between Nov10-Feb11
 - Only 5 offences were linked to 4 offenders who had been released from prison between Jul-Oct 2010
- If recent prison releases were considered to be responsible for the recent increase in burglary
 - Expected many more linked to burglaries that were committed during the Nov 2010 – Feb 2011 period

Explaining the burglary increase in Oldham

Hypothesis 2 (Less effective cocooning): The increase in burglary is attributable to a decrease in the effectiveness of “cocooning” in these areas, leading to a higher level of repeat and near-repeat victimisation

- Repeat victimisation:
 - Jul-Oct 2010: 3.1% of burglaries were repeats
 - Nov10-Feb11: 1.2%
- Near repeat victimisation:
 - Jul-Oct 2010:**
 - 7% of burglaries were near repeats
 - Evidence of near repeats within 2 days, between 200m to 300m from an initial burglary
 - Nov 2010-Feb 2011:**
 - 9%
 - Evidence of near repeats within 2 days, and within 200 metres around an initial event
- If near repeats were reduced to levels in Jul-Oct10, this alone could contribute towards 4% reduction in burglaries (1 in 5 additional burglaries were near repeats)

Near repeats by police beat area

N'hood	Beat	Beat Name	Jul-Oct 2010	Nov10 -Feb11	Diff
Q1	Q1E5	Coldhurst	2	7	5
	Q1F5	Werneth	0	12	12
	Q1G5	Medlock Vale	4	0	-4
	Q1H5	Alexandra	10	12	2
Q2	Q2J1	Oldham town centre	0	0	0
	Q2J5	St Marys	2	9	7
	Q2K5	Waterhead	10	9	-1
	Q2L5	St James	0	6	6
Q3	Q3Q5	Failsworth West	0	2	2
	Q3R5	Failsworth East	2	0	-2
	Q3S5	Hollinwood	2	7	5
Q4	Q4T5	Royton North	4	0	-4
	Q4U5	Royton South	2	1	-1
	Q4V5	Shaw	0	0	0
	Q4W5	Crompton	0	6	6
Q5	Q5M5	Chadderton North	6	3	-3
	Q5N5	Chadderton Central	13	4	-9
	Q5P5	Chadderton South	7	2	-5
Q6	Q6X5	Saddleworth South	0	10	10
	Q6Y5	Saddleworth North	0	0	0
	Q6Z5	Saddleworth West and Lees	2	2	0

Explaining the burglary increase in Oldham

Hypothesis 3 (Targeting jewellery): The increase in burglary has been driven by an increase in gold jewellery thefts, particularly in Asian (Indian) neighbourhoods.

- Jul-Oct 2010: 58 burglaries where jewellery was stolen (11% of all burglaries)
- Nov 2010-Feb 2011: 71 burglaries where jewellery was stolen (12%)
- Jewellery remains popular item to steal; difficult to distinguish 'gold'
- Increase in burglaries where jewellery was taken accounts for 5% of the total increase in burglary
- Targeting of Asians: no evidence to support this
- No hotspots of burglary for jewellery

Summary and interpretation:

- Jewellery continues to be common target, can't determine gold from other jewellery, overall increase is small
- No evidence to suggest any particular ethnic group or geographic area
 - Rather, areas where there has been increase in jewellery burglaries are areas which have experienced an increase in burglary generally

Explaining the burglary increase in Oldham

Hypothesis 4 (Darker evenings): The increase in burglary is attributable to an increased opportunity for burglars to offend in the early evening due to the extended hours of darkness over the winter

Time of day 15:00 – 20:59:

- Burglary increased 98% in Nov 2010–Feb 2011 compared to the same period in Jul – Oct 2010
 - Increase is equivalent to approx 100 more burglaries
 - Equates to 18% increase in burglary in Oldham
- Other hours of day: remained comparable to summer period
- Pattern has been evident in each of the previous 3 years

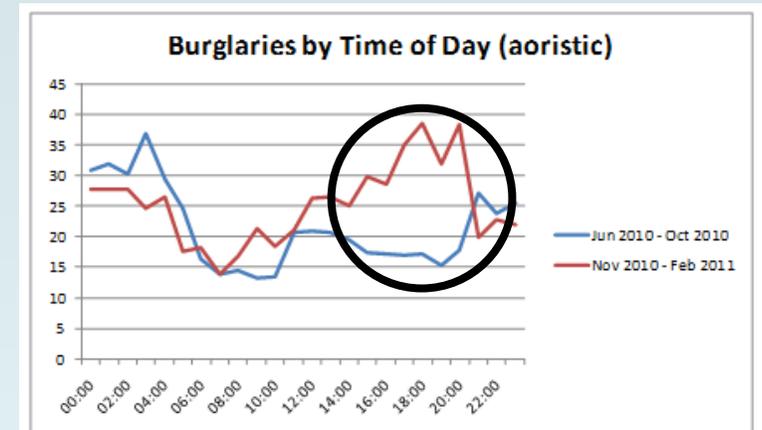
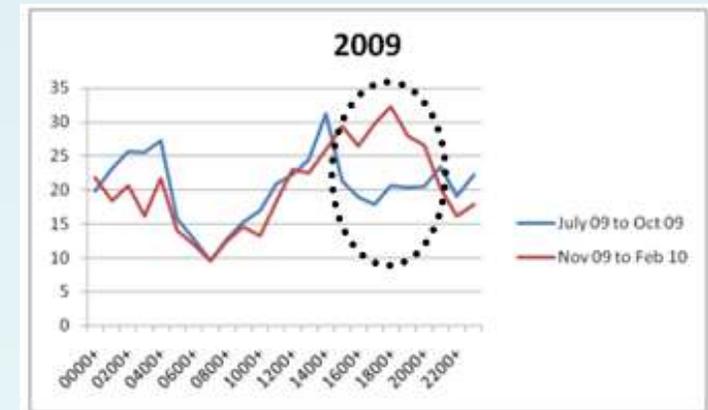
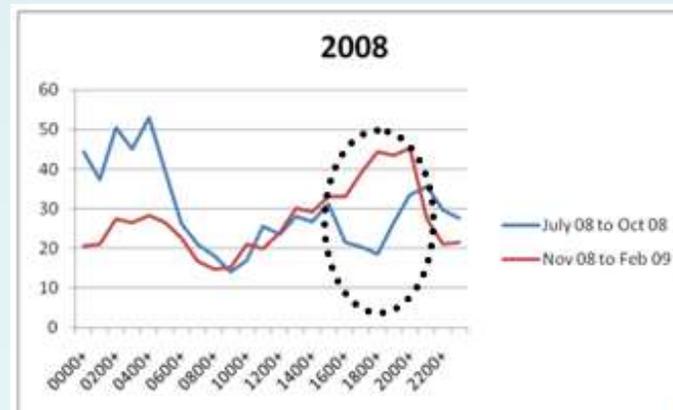
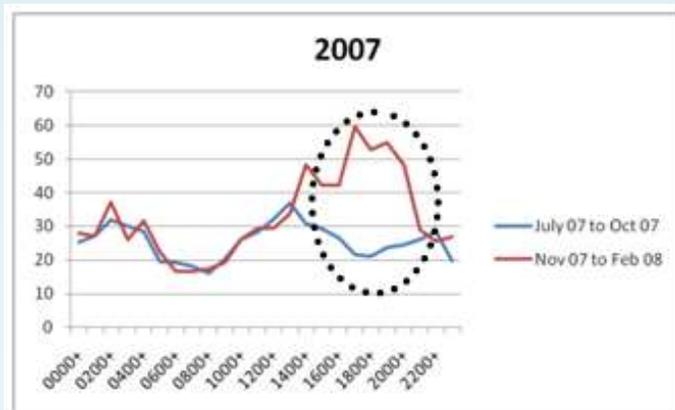


Figure 11. Time of day when burglaries were committed in Oldham, comparing Nov 2010- Feb 2011 to Jul – Oct 2010



Did the analysis make a difference?

Police and partnership response (October 2011)

Prevention focus (the introduction of super-cocooning!)

Reduce seasonal vulnerability; minimise near repeats

- Visit neighbouring properties; as much face-to-face contact with residents as possible:
 - Inform – Reassure – Advise
(start with those within 100m)

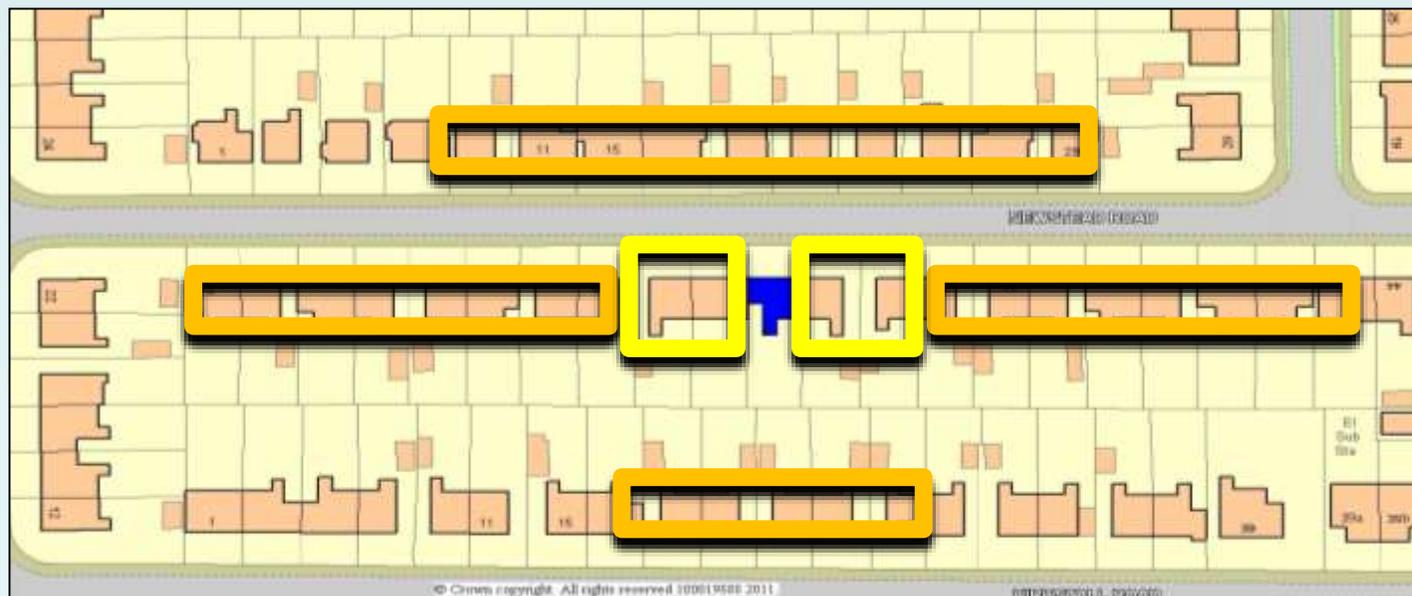


“I’m not sure whether you are aware, but there was a burglary a few doors up yesterday.

The chances of you being burgled are very low.

There are a couple of things you can do to help us out”

- Report suspicious behaviour
- Offer seasonally-sensitive, tailored crime prevention advice



Did the analysis make a difference?

- Nov 2010 – Feb 2011: 606
- Nov 2011 – Feb 2012: 457



- **Reduction of 25%**
- Specific reductions in near repeat victimisation
- Unanticipated benefit: Increase in public confidence

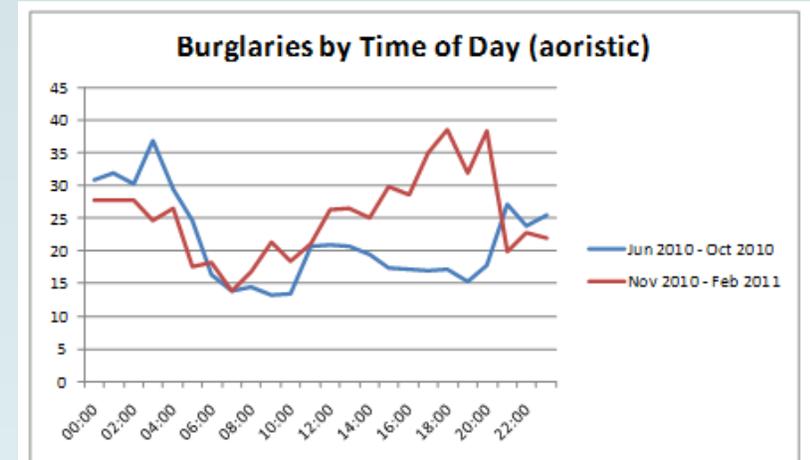
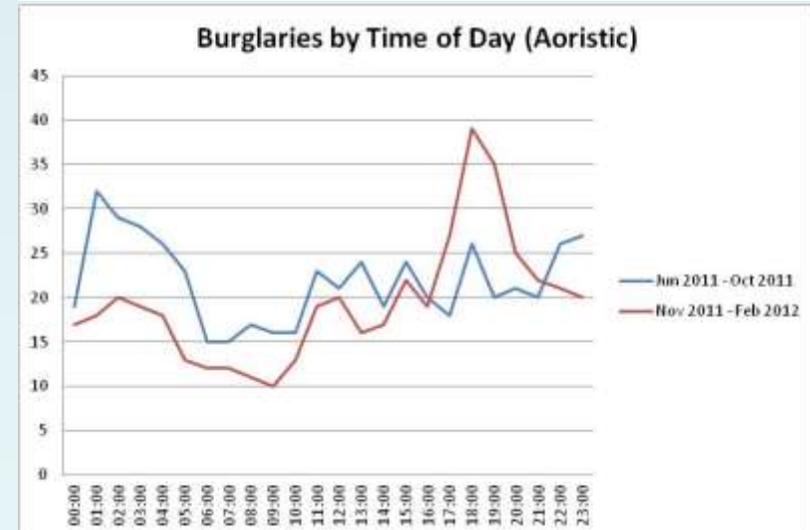


Figure 11. Time of day when burglaries were committed in Oldham, comparing Nov 2010- Feb 2011 to Jul – Oct 2010



Practical considerations

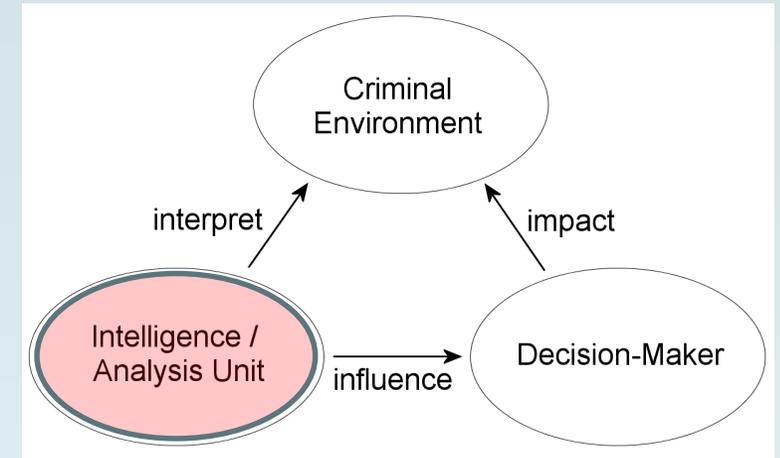
- Approach does not provide all the answers!
 - Explains several of the main causes
 - Myth busting
 - Identifies key intelligence gaps
 - Analysis product richer in explanatory substance
- Encouraging key stakeholders/decision-makers to suggest hypotheses improves commissioning
 - Actually results in some dialog!
 - Better involves them in interpretation of analysis results
- Involving number of different agencies leads to richer range of hypotheses

Some examples hypothesis testing has been applied to

- Burglary
- Problematic street drinking
- Alcohol-related violence
- Theft from vehicles
- Youth cannabis use
- Street parking
- Street robbery
- Criminal damage
- Bicycle theft
- Illegal dumping of waste
- Cycling accidents
- Illegal flower sellers
- Email-based fraud
- Youth disorder
- Theft of vehicles
- Sexual assaults
- Street drug dealing
- Domestic violence
- Robberies in Post Offices
- Knife crime
- Mobile phone theft
- Metal theft
- Psychoactive substances
- Organised criminal groups
- Child sexual exploitation
- Illegal importation of puppies

Summary: the role of the analyst

- Helping to interpret the criminal environment by providing a thorough understanding of the problem
 - Determining why the problem exists
 - Being objective in the intelligence created (critical assessment)
 - Identify intelligence sources other than recorded crime data
 - Identify intelligence gaps
- The analysis stage should also involve drawing from the evidence-base



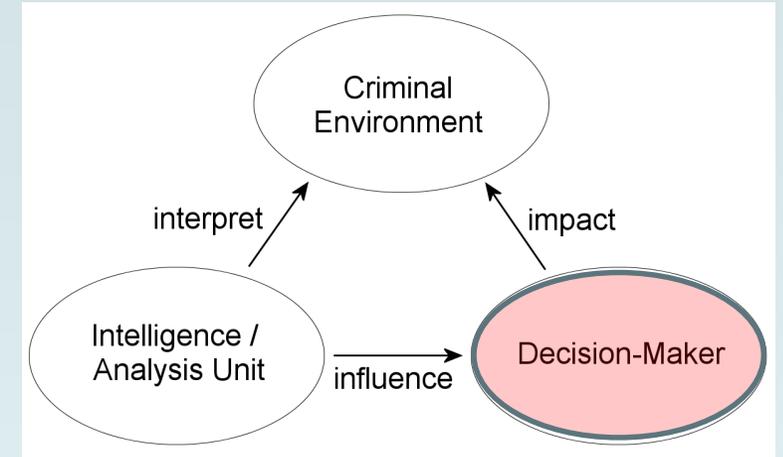
Crime analysis endeavours to provide the *“right information ... to the right people at the right time”* (Fletcher, 2000)

“Analysts should not simply provide management with statistics and colourful charts but a real understanding of criminal activity and the direction in tackling it”

UK Criminal Intelligence Strategy Group

Summary: the role of the decision-maker

- Ensure the product is fit for purpose
 - Clearly commission what is required
 - Converse rather than task ...
 - Identify a group of key stakeholders
 - Pose hypotheses
 - Set a realistic timeframe
 - Provide critical feedback



Crime analysis endeavours to provide the “*right information ... to the right people at the right time*” (Fletcher, 2000)

“Analysts should not simply provide management with statistics and colourful charts but a real understanding of criminal activity and the direction in tackling it”

UK Criminal Intelligence Strategy Group

Resources

Chainey, S.P. (2012) *Improving the explanatory content of analysis products using hypothesis testing*. Policing: A Journal of Policy and Practice.

Free access from the publications section of profile page:

<http://www.ucl.ac.uk/scs/people/profiles/spencer-chainey>

JDiBrief: Hypothesis testing crime analysis

www.jdibrief.com

Short courses:

Hypothesis testing crime analysis, 17 May 2016

<http://www.ucl.ac.uk/scs/cpd-events>

Bespoke course: Problem solving, analysis and implementing evidence-based responses

Contact me for details s.chainey@ucl.ac.uk

Article

Improving the Explanatory Content of Analysis Products using Hypothesis Testing

Spencer Chainey*

Abstract Analysis is an integral part of police and public safety decision making—if a crime problem is clearly understood, it can help identify the solutions that will most likely be effective. Although the profile of analysis has been raised in recent years, its routine production has often resulted in many analysis products often offering only a descriptive presentation of the problem that is being examined, rather than the one that is explanatory in its tone. In this article, we propose the use of a hypothesis testing methodology to improve the explanatory content of crime and intelligence analysis, and illustrate its use with an example of residential burglary in Oldham, Greater Manchester. We argue that this approach produces analytical products that are richer in explanatory and interpretative substance, helps to improve commissioning dialogue, and generates results that help to more specifically identify how a crime problem can be tackled.

Introduction

In the last 20 years, the growth of the intelligence-led paradigm in policing has placed a greater emphasis on the need to conduct analysis. The gathering of information and its interpretation is a key principle that underpins intelligence-led policing, be it for supporting the daily tactical and operational targeting of police patrols, assisting an investigation, or for identifying persistent issues that require a strategic response. The generation of good quality analysis is also at the heart of the problem-oriented policing approach introduced by Goldstein (1979, 1990).

The production of analysis has been formalized in several countries with the introduction of more

routinized management processes. For example, CompStat introduced in New York in 1994 (see Walsh, 2001 and McDonald, 2002 for more details on CompStat) and adopted in many other police departments in the World (e.g. UK (Home Office, 2005), Brazil (Beato, 2008), and Australia (Mazerolle *et al.*, 2011) requires the systematic production of crime statistics and other analytical material to support this operational management process. In addition, the adoption of police management frameworks such as the UK's National Intelligence Model (NIM) (NCIS, 2000) are designed to better integrate analysis and intelligence into the core of all police business and decision making (Ratcliffe, 2008). These more

*Department of Security and Crime Science, University College London, 35 Tavistock Square, London WC1H 9EZ, UK. E-mail: s.chainey@ucl.ac.uk

The value of using a hypothesis testing approach to improve the explanatory quality of analysis products

- Need to move on from producing descriptive, general material, that says very little, and usually what is already known!
- Hypothesis testing approach naturally leads to coming to some explanatory conclusions
 - Does not explain everything, but tests what are initially seen to be the main reasons
- Improves the commissioning process and the translation of analysis to response
- Class 5C: ACIA class: Analysis of competing hypotheses *Owain Gower, Sussex Police*
- 6B Seminar stream: The value of hypothesis testing in analysing organised crime *Matt Ashby, College of Business Law and Social Sciences, Nottingham Trent University*

Spencer Chainey, University College London

E: s.chainey@ucl.ac.uk W: www.ucl.ac.uk/jdi  @SpencerChainey