



Home Office

Social Network Analysis of an Urban Street Gang Using Police Intelligence Data

Research Report 89

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Table of Contents

Acknowledgements	3
Executive Summary	4
Background.....	4
Key findings	4
Discussion.....	5
Introduction	7
Background.....	7
Aim.....	8
Approach.....	8
What can social network analysis tell us about gangs?	12
1. Overall network	12
2. The form and organisation of the gang.....	15
3. Identifying and understanding gang related activities.....	16
4. Understanding wider links within the network.....	17
5. Profiles within the networks	19
How useful are the social network analysis outputs for the police?	24
Comparing results to local police experience	24
Use of networks.....	25
Practical concerns and value of the data	25
Use of police intelligence data	26
Discussion	27
References	28
Appendix	30
Section A: Police intelligence	30
Section B: Social network analysis software	31
Section C: Comparing the results to local experience.....	32

Disclaimer: 'The views expressed in this report are those of the authors, not necessarily those of the Home Office (nor do they represent Government policy).'

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Executive Summary

Background

As part of the Home Office's Ending Gang and Youth Violence programme a commitment was made to help police forces better understand their local gang issues (HM Government, 2013¹). This research aims to meet this commitment by testing the use of social network analysis using police intelligence data, as a tool to more systematically understand gangs and to help direct law enforcement activities. As such, the report serves as one example of how social network analysis can be used, but the approach could also be applied to other types of crime and disorder to explore the networks of people involved (such as those connected to acquisitive crime or sexual abuse).

The research was undertaken in partnership with Great Manchester Police and addresses two research questions:

1. What can social network analysis tell us about gangs?
2. How useful are the social network analysis outputs for the police?

For this, five individuals living in Manchester and identified as having gang links were chosen as the starting point for the network analysis. Further details about how to conduct social network analysis can be found in the '*How to guide*'² published as an annex to this report.

Key findings

What can social network analysis tell us about gangs?

An overall network of 137 individuals was identified, from the starting point of five individuals identified as having gang links. The relatively large network identified contained only a small number of people explicitly linked together by the police as being in a gang (18). Whilst individuals within the overall network are not necessarily gang members, all are potentially vulnerable to, or at risk from, gang association.

Links that were not explicitly criminal or gang-related (i.e. 'other social links' such as family, friendship or romantic links) made up a large proportion of the overall network and were important to its overall structure and how individuals link together. This demonstrates the importance of understanding how other types of links within a network might operate and how interventions aimed at disrupting a gang may be more effective if they take these relationships into consideration.

¹ Ending Gang and Youth Violence: Annual Report 2013. Available online: <<http://www.official-documents.gov.uk/document/cm87/8746/8746.pdf>>

² Social Network Analysis: 'How to' guide (2015). Available online: <<https://www.gov.uk/government/publications/social-network-analysis-how-to-guide>>

The social network analysis approach allows different types of links between individuals to be explored. Networks based on links identified as: gang-related, criminal, drugs-related (as a subset of criminal activity), and 'other links' were produced as well as one for drugs and 'other links' combined.

Gang sub-network: the 'known' gang was a highly interconnected group with no clear leadership structure or hierarchy. This was verified by police force representatives during the validation process and implies that the network may be challenging to disrupt as there was no clear leader to target.

Criminal activity: Drug activity was a particularly visible feature of the intelligence data (representing the majority of the criminal links). The drugs sub-network potentially highlighted the presence of several drug markets in this relatively small Manchester area. However, the addition of 'other' links to the network indicated a much more interconnected network than initially thought. Furthermore, those explicitly seen as being in a gang did not commit crimes in isolation (i.e. only with others in the gang), but with other people as well.

A range of profiles of individuals were identified within the data based on levels of connections between individuals. Individuals could be classified as peripheral, central, highly visible or gatekeepers. Discussions with police representatives supported the idea that interventions aimed at tackling gangs could be more effective if they were specifically tailored to take account of individuals' profiles within the networks.

How useful are the social network analysis outputs for the police?

Police force representatives from Greater Manchester were broadly positive about the value of the network analysis approach for operational and strategic planning. For example, the analysis highlighted connections between two recognised gangs in the area which had previously not been linked. Findings were largely validated in discussions compared to individuals own knowledge and experiences, and through looking at their crime and intelligence data.

The systematic approach taken had pros and cons. On the one hand, it meant individuals with no knowledge of the intelligence data could do the coding. This had the potential to remove any bias from the picture presented. However, police force representatives thought it may not be as flexible as their more qualitative approach which could give impressions of the network whilst it was being constructed. It was also felt to be more time consuming though in reality it was not. There would be merit in considering different applications of the systematic versus qualitative approaches. The former may be better when there is little known about an issue in an area and an objective overview would be helpful, and the latter to explore more detailed and specific questions once this picture is known.

Suggestions for improvements to the outputs included adding information to the network diagrams to aid interpretation (e.g. photos to help put names to faces) or looking to supplement them with data from other agencies.

Discussion

The study demonstrated the potential of the social network analysis approach for building a more nuanced and systematic understanding of a local gang problem using police intelligence data which could be used to help target police activities. This could also be applied to other crime types where networks may be present. As the example presented uses only Greater Manchester Police data, results are not intended to be representative of local gangs – just what was observed in Manchester during the study period.

The approach provided useful information about individuals potentially at risk from gang association. The added value of using intelligence data, rather than just focusing on crime data, was highlighted by the wealth of non-criminal links in the overall network. This shows how important it is to understand these non-criminal links if disruption activities are to work, and to identify people at risk of gang association to enable preventative policing. However, interpreting the findings should always be done in light of operational experience and with an understanding of how intelligence data are gathered. Data may be biased towards certain more visible activities or fail to record the direction of links between individuals – e.g. whether someone was acting 'with' or 'for' someone.

Background

The Ending Gang and Youth Violence programme aims to turn around the lives of those involved in violence (HM Government, 2011).³ The Ending Gang and Youth Violence Annual Report 2013 committed the Home Office to undertake “work with police forces to understand local gang issues, and to identify where it might be possible to intervene to encourage young people to move away from gang-association” (HM Government, 2013, p 36).⁴ To help meet this commitment this research aimed to explore the use of social network analysis as a technique to aid understanding of a local gang. This was done in conjunction with Greater Manchester Police, to test its feasibility as a tool to more systematically understand gangs and to help target police activities, including identifying those on the periphery of gangs as well as gang members.

Despite a long history of attempts to describe urban street gangs,⁵ barriers remain to developing a full understanding. These include potential biases in the reliability of local knowledge (Klein and Maxson, 2006; Rios and Navarro, 2010),⁶ the variable nature of gangs across areas (Disley and Liddle, 2015), and gangs having fluid and ‘fuzzy’ membership.⁷ Social network analysis offers a potential solution.

Social network analysis aims to understand a community (or sample of individuals) by systematically identifying and mapping relationships connecting members as a network. It assists in identifying key individuals, groups within the network, and associations between individuals. Hence, it helps understand the structure of the network and the profile or functions of individuals within it, and uses statistical tools to illustrate this.⁸

This report serves as an example of how social network analysis can be used in a policing context, using what has been recorded about individuals’ relationships in police intelligence data. Whilst the method has been used previously in areas such as counter terrorism (see, for example, Carley, 2003), it has not been used extensively to analyse police intelligence data. Though some forces are becoming increasingly aware of its potential and have begun to use it as an analytical tool. This work serves as an example to inform possible future use where understanding social networks could enhance policing, including in other contexts such as for acquisitive crime or sexual abuse.

3 Ending Gang and Youth Violence: Cross Government report (2011). Available online: <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/97862/gang-violence-detailreport.pdf>

4 Ending Gang and Youth Violence: Annual Report 2013. Available online: <<http://www.official-documents.gov.uk/document/cm87/8746/8746.pdf>>

5 For example: Thrasher, 1963; Hallsworth and Young, 2004; Centre for Social Justice, 2009; Densely, 2013.

6 They argue, in the US, that organisational and institutional factors may bias practitioners’ perceptions of gangs.

7 Disley and Liddle, 2015; Aldridge and Medina, 2008; Bennett and Holloway, 2004; Hallsworth and Young, 2004; Khan *et al.*, 2013; Pitts, 2007.

8 As noted by Carley (2003, pp. 2-3), much social network analysis focuses on “characterizing the size and shape (topology) of the underlying networks, identifying who stands out (which individuals by dint of their relations to others occupy key positions in the network), and [how the] structure of the network or the individuals’ positions within it influence behaviour”.

Aim

The research aims to test the use of social network analysis using police intelligence data, to help understand a local gang problem. It focuses on two research questions:

1. What can social network analysis tell us about gangs?
2. How useful are the social network analysis outputs for the police?

Approach

Before embarking on the social network analysis the following issues had to be addressed:

- identifying a suitable police force willing to allow access to data and provide resources to help ensure coding was accurate – Greater Manchester Police⁹;
- identifying police systems for extracting the data – local police force intelligence system (see appendix, section A)¹⁰;
- accessing suitable network analysis and data visualisation software with potential for wider use at minimal cost (see appendix, section B);
- agreeing coding frameworks and setting some parameters for the research, namely:
 - identifying a gang to be the focus of the network analysis. In discussion with police force analysts it was decided to focus on a gang predominately operating in one neighbourhood ward and about whom little analysis had previously been done.
 - identifying individuals with links to the gang to map. Ten individuals of particular interest were identified by police representatives. Five were then selected at random as the basis of the network (in order to provide a manageable sample size).¹¹ All five were male, white and aged between 16 and 21 (mean age 18.6).
 - agreeing the number of intelligence sweeps to code. Two sweeps were conducted.¹²

In using a relatively small amount of intelligence data from one area (Manchester), this work is an example of using social network analysis – findings are not designed to be representative of gang networks nationally.

Data collection

Detailed guidance on how to conduct a similar social network analysis is included in a separate '*How to guide*' published as an annex to this report.¹³ Below is a brief summary of the steps.

9 Following consultation with the Home Office's Ending Gang and Youth Violence team and representatives of the Police IT Company, Greater Manchester police was approached to work with on this project. The force had a dedicated gangs' team and a central intelligence analyst function. Two intelligence analysts supported the data collection process for the project.

10 Feasibility work ruled out the possibility of using the police national database (PND) for the analysis for practical reasons (e.g. access restrictions and time taken to run queries). There are several different intelligence systems in use in police forces across England and Wales and it is recognised that using a local force system may limit the applicability of the precise process. However, it is hoped the process will have national resonance and the guidance provided will be able to be adapted locally.

11 The remaining five individuals appeared in the overall network indicating, to some extent, the robustness of the network.

12 After identifying the five individuals who would form the basis of the network a sweep of intelligence logs was conducted to find all logs naming them. Individuals identified within those logs were coded and then a second sweep was conducted for those named within the first sweep logs. This process could be repeated any number of times but it was decided to stop after two sweeps.

13 Social Network Analysis: 'How to' guide (2015). Available online: <https://www.gov.uk/government/publications/social-network-analysis-how-to-guide>

1. Police intelligence data¹⁴ concerning the five individuals identified as having gang links ('primary individuals') going back six months were collected (retrospectively).
2. Individuals mentioned in these data ('secondary individuals') were identified.
3. Relationships between primary and secondary individuals were coded by category (see below) and input into a database.
4. Police intelligence data concerning the secondary individuals going back six months were collected and coded as above.
5. Other individuals mentioned in these data were identified.
6. Relationships between these individuals and the secondary individuals were coded as above (by category).

Data coding

Relationships between individuals were coded according to a framework which recorded suspected or charged criminal relationships, relationships that were not explicitly criminal ('other social links'), and the nature of the relationship (e.g. perpetrated crime against). Where links were criminal, the direction of the relationship was also recorded (whether a crime was committed by person A with person B, committed by A for B, or A had done something to B – e.g. sold drugs to).¹⁵ In this way, a database of individuals and their relationships was constructed.¹⁶ The resulting data were then analysed as a social network.

The process identified almost 600 links between individuals, which were then filtered according to grade of intelligence to give over 424 'most reliable' links. It should be noted that this short report does not cover all of the analyses possible with the data collected. For the purposes of this report a unique identifier represents all individuals anonymously. It is however possible to create the networks with more detailed information about the individuals (such as names and/or photos) for operational purposes and other useful information might also be included (e.g. photos, phone numbers, car registration numbers) to make the analysis more accessible.

Data validation

Semi-structured interviews and focus groups were conducted with Greater Manchester Police force representatives (including intelligence analysts, police officers and police community support officers). This enabled key results to be discussed in an operational context but results were not extensively tested due to time and resource constraints.

Data analysis and interpretation

There is no set way of undertaking social network analysis, it depends upon the questions being investigated. Table 1 provides explanations of the key social network analysis terms and statistics produced for this report. To note, network diagrams can be adapted further than those used in the report e.g. scaling the nodes or links to represent the number of connections or

14 Grade B22 and above – see appendix, section A for an explanation of the intelligence grades.

15 Other factors could easily be incorporated into the data collection process to allow additional exploration e.g. geography.

16 A separate 'attributes' database was built for any related criminality (suspected or proven), but is not analysed in this report.

strength of the intelligence data. However, we chose not to do this given limitations around the accuracy of the police intelligence data used.

Limitations

There are several potential limitations to this analysis.

- **Data accuracy:** The analysis can only be as good as the data it is based on. The accuracy and comprehensiveness of police intelligence data is uncertain. It can be influenced by operational activity and by the understanding of those who record the intelligence. It also represents a snapshot in time so there may be individuals who do not feature (i.e. those in prison), and the fluid nature of gang association may mean structures vary over time. This is however a limitation of the social network analysis approach in general.
- **Simplifications:** The analysis involved some simplification – for example, geographic location of individuals in the network was not included. Other aspects that were not examined but may be important include: time, family ties, residential ties, and other legitimate social connections (e.g. through school or work).

Limits were placed on the data collection in order to keep this to a manageable size (e.g. setting a limit on the number of sweeps of intelligence data to conduct, limiting the grade of intelligence used). This will have limited the size and complexity of the networks produced.

Table 1: Network statistics

Statistic	What is shows	Explanation
Size		
Number of nodes – the people in the network	Size of the network	Number of individuals in the network
Number of links – social connections/relationships between nodes (e.g. friendship, family ties)	How ‘busy’ the network is in total	Number of relationships between individuals in the network (in total)
Number of unique links	How ‘busy’ the network is, taking out relationships that are duplicated	Number of relationships between individuals in the network, with duplicates removed
Cohesiveness		
Number of components – distinct groups in the network	Whether there may be sub-groups in the network	Number of discrete groups in the network
Density	The extent to which nodes are interconnected – lower density networks have fewer links between nodes	The proportion of all links that are actually present
Diameter	Size of the network	Greatest number of steps between any pair of nodes
Mean average distance	How ‘close’ (in network terms)	Average number of steps needed

between nodes	the nodes are to each other	to go from one node to any other
Centrality		
Mean degree	How central (on average) nodes in the network are	The average number of links an individual has. The more ties, the higher the degree of centrality
Mean betweenness	How central (on average) nodes in the network are	Average number of unique paths that pass through the nodes. The higher the betweenness the more of a 'gatekeeper' they are

What can social network analysis tell us about gangs?

The following sections explore what social network analysis tells us about gangs, using this specific example from Manchester. It covers the **overall network** formed from the data and then a **sub-network for gang only** links. It also covers **sub-networks on criminal activity** and, within that, **drug-related** activity. Finally, it looks at **'other social links'** identified in the data (i.e. links that aren't criminal or gang related).

Key findings

- The social network analysis identified a large number of individuals linked to the relatively small number of people explicitly recognised as being in a gang by police. Not all of this community may be seen (or see themselves) as gang members, but all are potentially at risk from gang association.
- The size of the 'other social links' network (i.e. those not crime or gang linked) indicates that social links are very important to the cohesiveness of the overall network. Interventions aimed at disrupting gang networks might therefore be more effective if they take into consideration relationships between individuals that are not explicitly criminal.
- The 'known' gang had no clear leadership structure but was highly inter-connected, compared to other groups in the overall community. This implies that it may be challenging to develop law enforcement approaches from the intelligence data to disrupt this gang as there was no clear leadership to target.
- A range of profiles were identified within the data based on the levels of connections between individuals. Individuals were classified as peripheral, central, highly visible or gatekeepers. Discussions with police supported the view that interventions aimed at tackling gangs could be more effective if tailored to target the characteristics of particular groups or individuals within networks.

1. Overall network

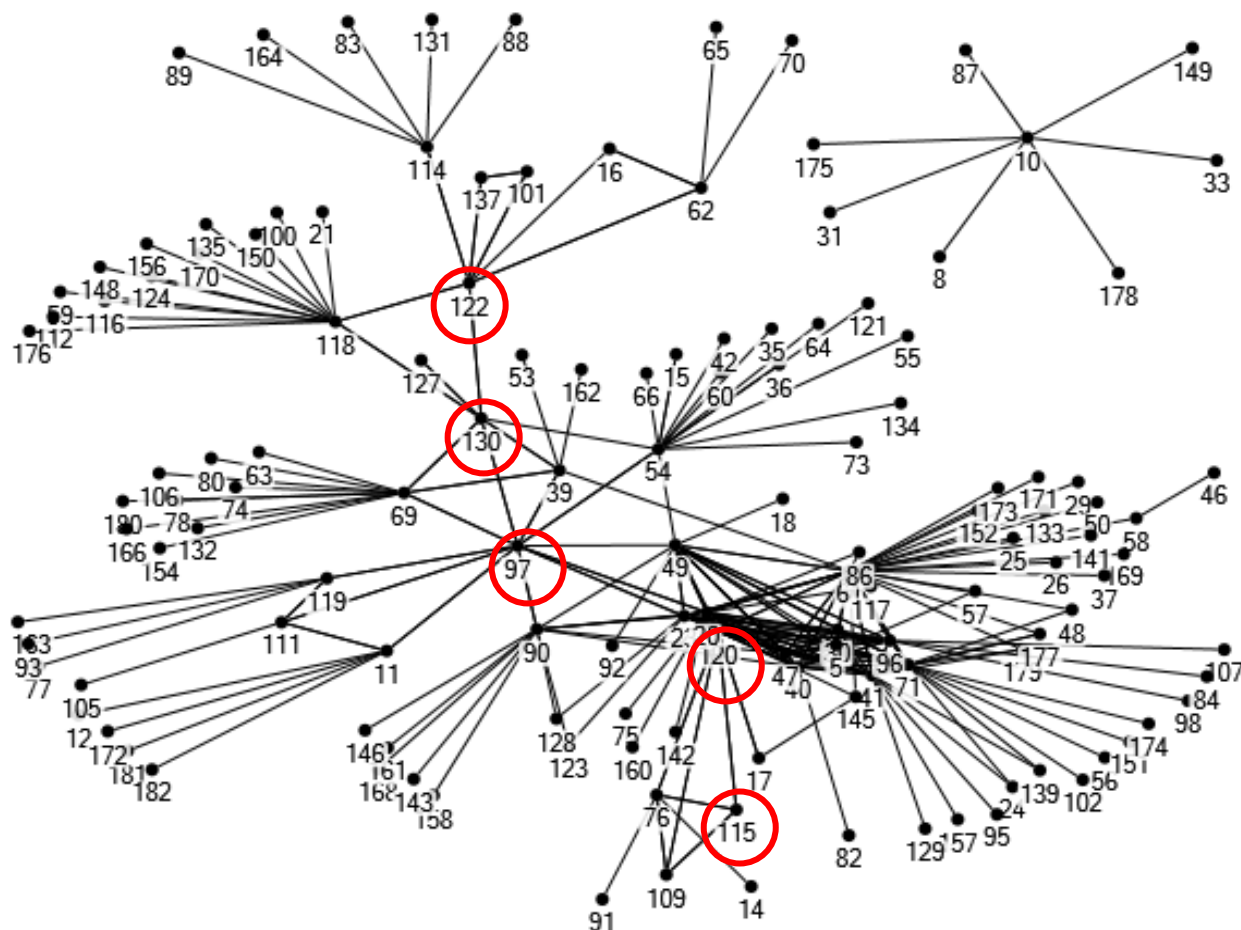
From the starting point of five individuals (identified as having gang links – circled in Figure 1 and, where they occur, in subsequent figures),¹⁷ a network of 137 individuals/nodes was produced from the intelligence data.¹⁸ The size of the network, from these five individuals and two sweeps of intelligence data, illustrates the wide reach of the gang. It is important to note that individuals in the overall network may not all be regarded by the police, or themselves, as gang members. Rather, they are potentially at risk of being involved in gang activity, or at risk of harm through being connected with the gang.

17 The Harel-Koren method was used to arrange the networks in this report (other options are available which explicitly set a hierarchical arrangement for instance). While this method can tend to make particularly 'busy' parts of the network unclear, it was considered to provide the most intuitive diagrams for the present context.

18 To note, the position of the nodes are rearranged for each of the networks. The physical (geodesic) arrangement of the nodes is not of interest for the present analysis, only the links between them.

The individuals/nodes in the bottom right of the network are particularly highly connected (in network terms, more 'densely' packed). They largely comprise those explicitly identified by intelligence data as being in the same gang. However, there are large numbers of individuals in close contact with the 'known' gang, illustrating the difficulties experienced with defining a 'core' gang.

Figure 1: The overall network



Key statistics are used to describe and interpret the networks (Table 1 describes terms used). Table 2 gives figures for all of the networks, which includes the overall network (Figure 1) and sub-networks on criminal activity, drug related activity, 'other social links', and the combined drugs and 'other social links' network. Key aspects include:

- *Network size* – police intelligence data contain network information on relationships that are not explicitly criminal (i.e. 'other social links'). There are 115 individuals in the 'other social links' sub-network compared to 45 in the 'criminal links' sub-network and 31 in the 'drug links' sub-network. Additionally, there are more links between individuals (226 in 'other social links' compared to 69 in 'criminal links'), demonstrating the importance of the 'other social links' to understanding how the gang and criminal networks might connect;
- *Network cohesiveness* – comparing the density of the networks (the proportion of potential links that have actually been made) the 'gang links' sub-network is the densest (e.g. 0.189 compared to 0.051 for 'criminal links'). This suggests individuals in the gang sub-network are more active than those in the other networks (or their actions are more visible in the intelligence data);
- *Components within networks* – the higher number of components (distinct groups) in the sub-networks compared to the overall network highlights that apparently disparate

groups in some networks are in fact connected when you consider different types of links. Again demonstrating the importance of considering a range of types of links to help build understanding of the local problem.

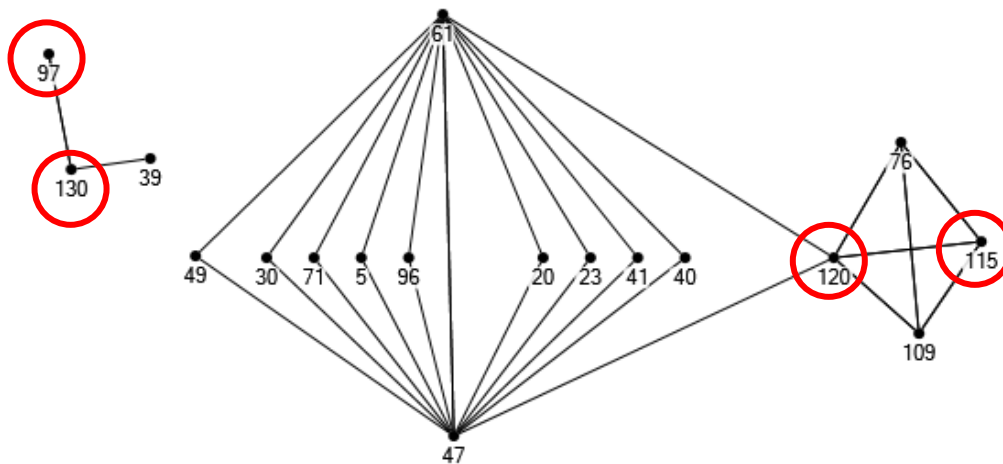
Table 2: Key statistics

Statistics	All	Gang links	Criminal links	Drugs links	Other social links	Drugs and other social links
Size						
Number of individuals	137	18	45	31	115	124
Total links between individuals	303	37	69	53	226	257
Cohesiveness						
Components	2	2	5	3	7	3
Density	0.024	0.189	0.051	0.082	0.027	0.026
Diameter	7	3	6	4	6	7
Mean distance	3.75	1.83	2.63	2.12	2.53	3.70
Centrality						
Average degree ⁺	7.96	3.50	4.24	4.21	7.51	7.80
Unadjusted	3.29	3.22	2.22	2.45	3.10	3.19
Average betweenness ⁺	852.52	26.50	54.42	32.13	147.75	702.50
Unadjusted	168.02	5.89	14.51	8.29	30.84	147.30
Notes						
<ul style="list-style-type: none"> • 'All' links is not the sum of the sub-networks links, as some links were counted in more than one sub-network. In all, 424 intelligence logs were coded. • Drugs links are a sub-set of the crime links (i.e. crime links also include drugs links). 						
<p>⁺ This presents a rough picture of the distribution, and has been calculated by taking the mean (nodal) degree excluding values of 1, as including these skews the average. Average betweenness is the mean betweenness excluding values of 0 (for the same reason). This was felt to adjust for the fact that the network was stopped after two steps, and so included many peripheral individuals. The unadjusted values show the average without these exclusions.</p>						

2. The form and organisation of the gang

Looking at the overall network is useful to explore the reach of the gang and to help identify potentially gang associated individuals. This provides an indication of the 'state' of the gang from a police intelligence data perspective. Figure 2 illustrates the gang only sub-network.

Figure 2: Gang links only sub-network



Gang sub-network

The 'gang links' sub-network comprises 18 'gang members' identified from the intelligence data. Comparing this to the overall network (Figure 1), the 'known' gang members represent some of the core of the overall community, as they are heavily involved in the 'busy' parts of the network (the middle section of the diagram). The starting individuals do not appear to be very important to the sub-network, and one is not actually a part of it at all – i.e. the data did not explicitly identify them as a 'gang member'. How to interpret this, in the context of data quality considerations, is discussed below.

The network statistics highlight other interesting findings:

- *Cohesiveness* – the relatively high density of the 'gang links' sub-network (0.189 compared to e.g. 0.024 for the overall network) indicates a higher level of interconnectedness between individuals meaning individuals are less important to the gang network than other networks. This, coupled with the low mean distance between individuals, shows the closeness of this sub-network compared to the others.
- *Centrality* – individuals in the 'gang links' sub-network have lower centrality scores on average than individuals in the other networks. They have fewer links passing through them, on average (e.g. 3.5 links compared to e.g. 7.5 in the 'other social links' sub-network) and a lower number of unique paths (26.5 compared to 147.7 in the 'other links' network). Interpreting this is difficult but possibly indicates that specific individuals are less important to the 'gang links' sub-network as their connections are duplicated by others – a conclusion supported by the fact that the 'gang links' sub-network is relatively densely packed, according to Table 2.

The cohesiveness and centrality scores above, alongside an examination of Figure 2, indicate that this Manchester network may be difficult to disrupt, in this example, as the removal of an individual (or even several people) may not greatly affect the sub-network as a whole. Clearly, however, removing particularly key individuals (e.g. 120, 47, 61) may fragment the sub-network.

It is possible to identify such individuals statistically, as discussed in section 5. This was confirmed by looking at the causal direction of links within intelligence data which found that activities were all seen to be undertaken ‘with’ rather than ‘for’ someone in the network – suggesting the structure of this ‘known’ gang in Manchester is relatively flat and not hierarchical.

The apparent absence of clear leaders in this specific Manchester example accords with a lot of the research literature on gangs, which states that gang associations are maintained through close ties and there may be no rigid hierarchy. However, the finding may also be due to the visibility of activity - if leaders are not as active in street-based activity they may not feature as much in intelligence data. Additionally, while the intelligence data identified no clear hierarchies, this could simply reflect the way it was collected and/or recorded. In saying this, Greater Manchester Police representatives involved in the validation process confirmed that they believed the flat hierarchy was representative of this specific gang.

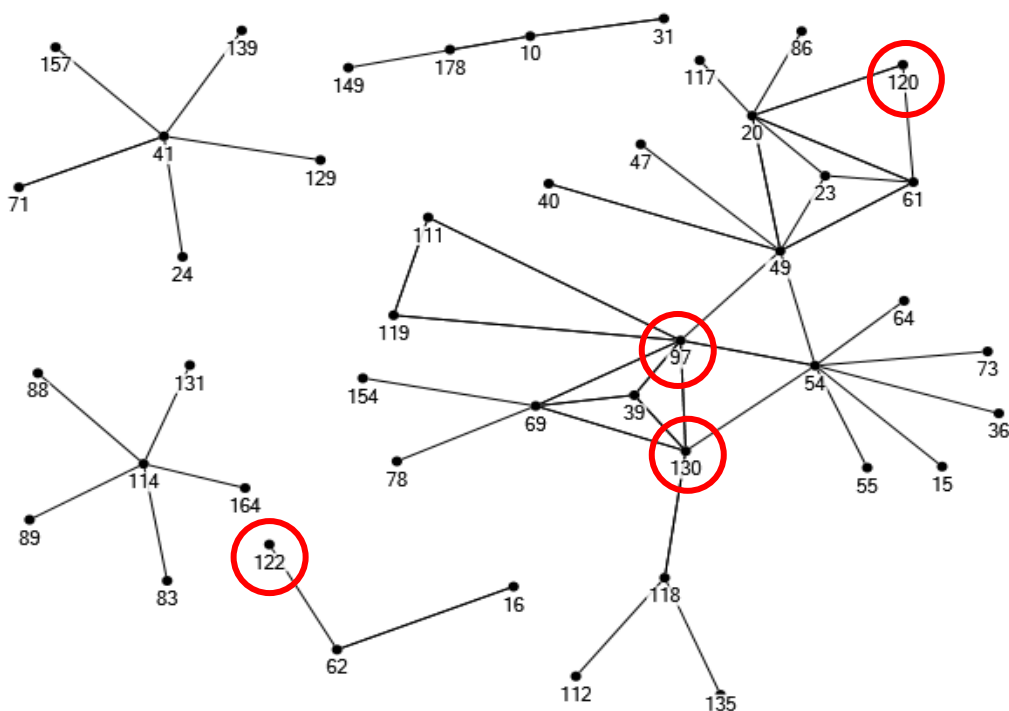
3. Identifying and understanding gang related activities

This section explores criminal and drug sub-networks evident from the data. It should be noted that other factors could easily be incorporated into the data collection process to allow additional exploration, such as, geography and relationships.

Criminal links

Figure 3 shows the criminal links sub-network (i.e. only those where police intelligence data specifically referred to a criminal act). It does not include gang links, but shows which individuals operate together criminally.

Figure 3: Criminal links only sub-network



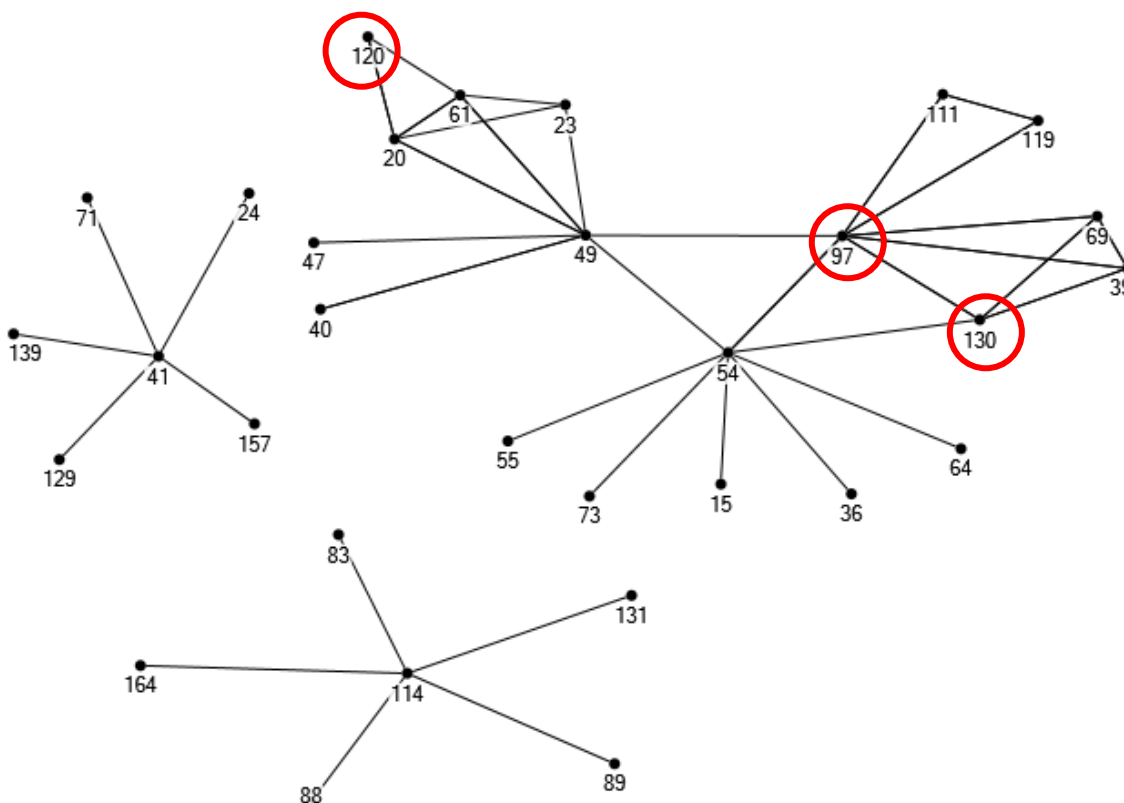
The criminal links sub-network comprises 45 individuals, only 12 of which are ‘known’ gang members from the gang links sub-network. This indicates that those explicitly seen as being in a gang were involved in crime with others that were not seen to be in the gang. Hence, there is evidence of the gang having a wider criminal footprint.

Drug-related activity

Drug dealing is a particularly visible activity and is likely to feature heavily within police intelligence data, and therefore in the overall network. It is also a major feature of gang activity in general (e.g. Disley and Liddle, 2015) and in Greater Manchester as confirmed by police representatives prior to the analysis. Figure 4 shows the network created from intelligence data specifically indicating a drug link. The size of the network (31 individuals) compared to the 'criminal links' only sub-network (45 individuals) confirms the importance of drugs activity to the local crime problem.

The network diagram potentially indicates the presence of several drug markets in operation in the area as there are three distinct components (or groups) in the network. Discussions during the validation exercise with police representatives suggested that the analysis captured two recognised gangs in the area which, up until now, they had not linked together.

Figure 4: Drugs links only sub-network



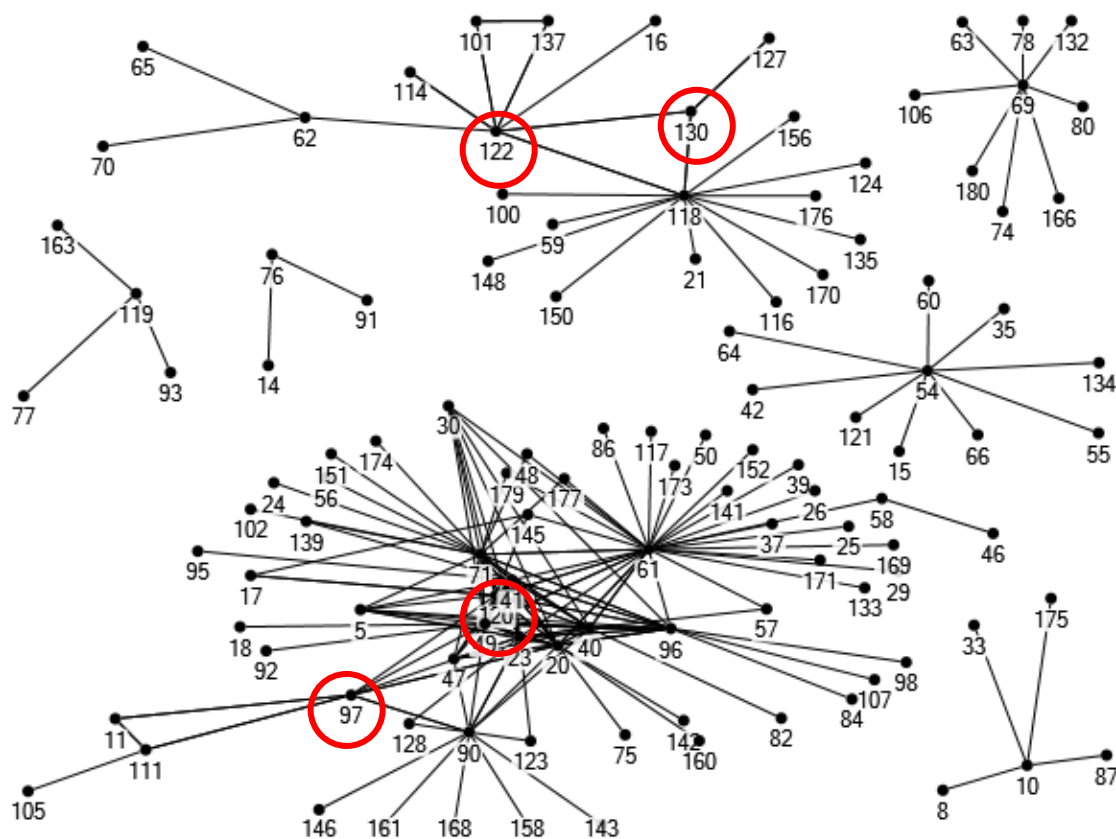
4. Understanding wider links within the network

While it is possible to use social network analysis to focus on criminal and/or gang-related links, the value of using police intelligence data (rather than just looking at crime data) is that broader links can be included. These data are important when trying to understand what might underpin relationships. Figure 5 shows the network for 'other social links' (i.e. those not explicitly stated as criminal, gang or drug links) these include links such as family, friendship, and romantic links.

This analysis shows how relationships that were not explicitly criminal or gang linked are prominent in the overall network (even though these relationships are likely to be under-represented in police intelligence data). This stresses the importance of not trying to understand gangs by looking at criminality alone. For example, the large number of ‘other social links’ (115 compared to 46 criminal links) may make it difficult to disrupt criminal networks, as another link could potentially replace a criminal link and, in turn, become a criminal link. The links between different networks may also highlight potential exposure of individuals to crime (i.e. those who might be vulnerable to being drawn into crime through other social links).¹⁹

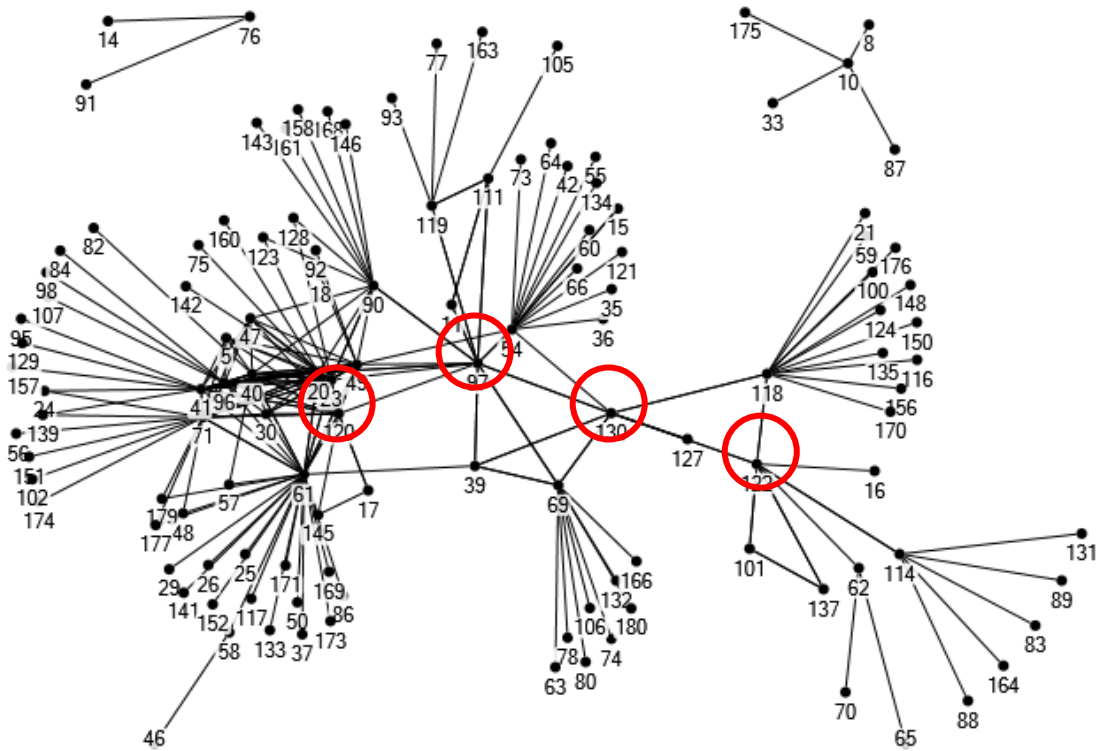
To further illustrate the value of looking at other types of links (i.e. social ones) it is possible to overlay different types of links into a new network – Figure 6 combines drug links with ‘other social links’. The results indicate a much more interconnected network than would be suggested from the ‘drugs only’ sub-network alone (Figure 4): the three components of the drugs sub-network are actually connected via other social links. From an enforcement perspective, this may make the network more difficult to disrupt than would originally have been thought from the drugs only links sub-network. In addition, particular individuals can be identified as potentially important within this network (something described in more detail in the next section). For example, individual 122 may be important to consider as he/she appears to connect two distinct components within the ‘drug links’ only sub-network through individuals 114 and 130 (Figures 4 and 6).

Figure 5: Other social links sub-network



¹⁹ Having delinquent peers has, for instance, been identified as a risk factor for offending (e.g. McCord et al., 2001 cited in Shadler 2004).

Figure 6: Drugs and other social links



5. Profiles within the networks

The importance of understanding the profiles of individuals within a network was highlighted in the previous section (e.g. when interpreting the ‘drug links’ sub-network). Some individuals are clearly more or less central than others, and it is possible to explore this using a statistical approach.

The importance of individuals within a network is characterised in two ways: the *number* of others an individual is linked to; and, *how uniquely* they are linked to others. Where an individual sits on these two scales indicates how central or peripheral they are to the network. Centrality statistics are used to unpick individual profiles within networks as follows:

- degree – the higher the degree of centrality the more links an individual has; and,
- betweenness – the higher the betweenness, the more uniquely the individual links others.²⁰

Figure 7 plots the centrality scores for the overall network, with Table 3 providing the centrality statistics for the sub-networks.

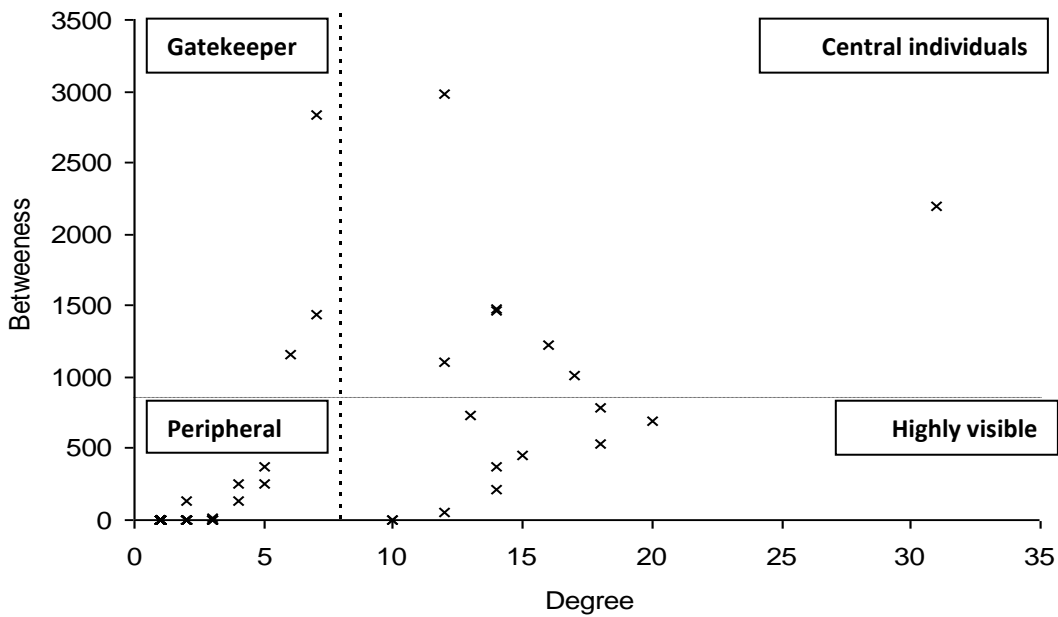
The profiles depicted in Figure 7 are described as:

1. **Gatekeepers:** uniquely connected to parts of the network, but not to many others
2. **Central individuals:** connected to lots of others and, for many, uniquely connected.

²⁰ Equal to the number of shortest paths from all vertices to all others that pass through that node.

3. **Highly visible**: connected to lots of other individuals. May be involved in lots of activity in the network, but do not play a unique role.
4. **Peripheral**: not very unique or very many links.

Figure 7: Centrality statistics for the overall network



Notes

- The crosses represent individuals in the network. To note - some of the crosses are overlaid as they represent the same score. Hence why 137 crosses are not necessarily visible.
- The mean degree and betweenness exclude 1 and 0 values (of which there were large number) as these skewed figures.

Table 3: Centrality of individuals in the networks

	Gatekeepers	Central	Highly visible	Peripheral	Total*
Overall network					
Frequency	3	7	10	117	137
Proportion	2%	5%	7%	85%	100%
<u>Gang</u>					
Frequency	0	3	0	15	18
Proportion	0%	17%	0%	83%	100%
<u>Crime</u>					
Frequency	0	5	3	37	45
Proportion	0%	11%	7%	82%	100%
<u>Drugs**</u>					
Frequency	0	3	2	26	31
Proportion	0%	10%	7%	84%	100%
<u>Other social links</u>					
Frequency	1	8	8	98	115
Proportion	1%	7%	7%	85%	100%
<u>Drugs and other social links</u>					
Frequency	3	6	11	104	124
Proportion	2%	5%	9%	84%	100%

* Proportions may not sum to 100% due to rounding

** Drugs links are a sub-set of the crime links (i.e. crime links also include drugs links).

Notes: Aggregate figures are provided to ensure anonymity but it is possible to identify the actual individuals (through their unique identifier) in the networks and, (potentially) use this to target action accordingly.

The results indicate that a large proportion (82% to 85%) of each of the networks comprises peripheral individuals. This could well reflect the police intelligence data used: apparently peripheral individuals may actually be very important, but a lack of intelligence on them could make them look inconsequential to the network.

The 'known' gang members are very important to all the networks. For example, they represent nine of the ten highly visible people in the overall network, and two of the three gatekeepers. The 'known' gang members therefore represent the core of the mapped networks, particularly in terms of criminal activity. This could reflect increased police activity on gang members relative to other individuals in the network, but it could also be an increased visibility of certain urban street gang members, and/or genuine increased levels of activity. Operational experience of local issues is crucial in interpreting findings.

Ten individuals were identified in the overall network as being highly visible: three gatekeepers and seven central figures. Apart from one individual in the ‘other social links’ network no other sub-network has any identified gatekeepers (not including the aggregated ‘drugs and other social links’ sub-network). Looking at the gang network in particular, the centrality analysis supports earlier findings around the absence of a clear hierarchy within this example in Manchester.

The practical relevance of this information is that some types of activity to tackle crime and disorder may be usefully focused on individuals with particular profiles. Table 4 gives some indication of how the information about the profiles of individuals within networks could be used to help focus such activity and the examples below illustrate why this might be useful.

- If looking to fragment networks – action might be prioritised on gatekeepers or central individuals as they may be the only connection point to others in the network. In the gang network (Figure 2), for example, individuals 120, 61 and 47 were the central individuals.
- If looking to spread or collect information – central and highly visible individuals may be prioritised, since they are connected with a higher number of individuals within the network.
- Anti-crime education may be focused on peripheral and highly visible individuals in criminal networks – those who are on the cusp of the activity, or are involved but not yet pivotal to the network, may be diverted away more easily.

Table 4: Example activities to target at different profiles within networks

Activity	Gatekeepers	Central	Highly visible	Peripheral
Fragmenting networks	✓	✓		
Collecting information		✓	✓	
Spreading information		✓	✓	
(For criminal networks) Anti-crime education			✓	✓

Decisions around actions to take should consider information on the profile of individuals alongside network statistics (Table 1), network diagrams, and operational experience. For example, there are proportionally more gang-linked individuals that can be described as central (17%) than in the overall network (5%).²¹ Other statistics show that the gang network is relatively densely packed and does not heavily rely on individuals. As such removing central figures individually is unlikely to adversely affect overall group cohesion. Instead, effort might focus on removing all of the central figures at the same time in order to have maximum impact.

Similarly, the large number of ‘other social links’ within the overall network may make it difficult to disrupt the criminal network in this Manchester example. If a criminal link is broken by enforcement action, an existing non-criminal relation could potentially turn into a criminal link

²¹ It should be noted that the overall number of nodes is small, so the proportions should be interpreted with caution.

and replace it. It is possible, however, to suggest the most sensible parts of the network to target with interventions, by looking at where removal of nodes would be most likely to have an effect and not be easily replaced.

How useful are the social network analysis outputs for the police?

The previous section, though not an exhaustive presentation of the analysis, aimed to illustrate the types of information that can be gleaned by using social network analysis. But, the research project also aimed to look at how such information might be useful operationally, in terms of helping areas to understand their local gang issues more objectively and helping to direct police resource.

Key findings

- Police force representatives in Greater Manchester generally validated the findings from the analysis saying they reflected their understanding of the gang in question and emphasised the importance of reviewing outputs in light of local knowledge and experience. Some representatives saw value in using the outputs to assist operational planning and for providing a strategic overview of the problem.
- Suggested improvements to the outputs included being able to differentiate between intelligence grades visually and include additional details on the networks such as photos of the individuals to help put faces to the network.
- The systematic nature of the approach had pros and cons. It meant that coding could be done by individuals who had no prior knowledge of the intelligence data, but it was potentially not as flexible as a more qualitative approach.

Comparing results to local police experience

Overall, the results presented by the analysis were seen to be in-keeping with the experiences of the police representatives who participated in the validation process. The analysis broadly reflected understanding of the gang in question and its non-hierarchical structure. It also identified a previously unrecognised (but suspected) link to another gang in the area. The profiles identified for known individuals within the networks were confirmed in many cases and for those less well known provided some useful additional insight. The importance of interpreting the data in light of all the outputs and alongside operational experience was highlighted though. In one example an individual identified as a gatekeeper actually had familial connections but was not known to be in the gang.

The size of the network (and in particular of the non-criminal links) emphasised the importance of looking beyond crime data. Other key aspects discussed are summarised in Table A3 appendix, section C.

Use of networks

The systematic approach offered by the network analysis was seen to be helpful to structure understanding around particular groups, and to avoid personal bias in constructing a picture. However, it also meant that results were not available until the end of the process and the individuals coding found it difficult to interpret the logs as they were reviewing them. This potentially makes the process less responsive to operational needs than their usual qualitative approach. It may be possible to use a different resource to undertake the coding process and use analysts' time to interpret and explore specific results. But resource pressures may mean that this is not viable. There is also value in considering when a systematic versus a qualitative approach may be most suitable. For instance, a qualitative approach may work best when you already have a reasonable understanding of an issue in an area or have very well specified questions for the data. The systematic approach may be better when there is less understanding and you need an overall, objective assessment of what is happening in an area. These two processes could also compliment each other by starting with an overview analysis then honing in on specific questions afterwards.

Some participants thought there could be benefit in using the networks to support cross team working, since they could illustrate how an individual of interest may be involved in more than one officers' remit.

Amendments to the outputs were also discussed. There were presentational aspects of the network diagrams that police representatives felt could be useful additions for operational purposes – both of which would be simple to implement using available software.

- Differentiating between the grades of intelligence graphically (e.g. having different coloured lines) might allow police officers to use their judgement about the robustness of particular links.
- Having the details of individuals (including photographs) available next to the nodes, so that officers could quickly get an impression of which individuals were in close contact and put 'faces' to the network.

Police representatives also suggested other sources of data that could usefully be added to the networks to improve understanding of local issues. These included:

- intelligence from prisons – in particular to help identify links which might continue (or change) when individuals are released from prison;
- information on premises and vehicles in the networks (i.e. to move away from just the 'social' aspect of the network analysis). While the former was seen to be potentially useful to investigate ties between individuals, it was felt that vehicles changed hands so often that this was unlikely to provide accurate information; and,
- lower threshold intelligence data which could potentially include valuable information. However, this may require making a judgement about each piece of data (and therefore be more time consuming) than applying a blanket threshold level.

Practical concerns and value of the data

Two main practical concerns were highlighted during the validation process.

- **Time taken for the process:** Police analysts felt the process took a long time to complete, particularly when compared to their usual approach of building network diagrams qualitatively. The methodical nature of the process meant it felt arduous to the analysts. But, it can be populated by anyone, not just those with expert knowledge of

intelligence analysis techniques. Furthermore, there is the possibility that automated coding techniques could be used to speed up processes. It should be noted that, even in this feasibility study, time taken to complete the social network analysis data collection overall was about the same as the existing approach and could become quicker with experience.

- **Applicability:** Police representatives reported that the way intelligence analysts were tasked and worked with officers might limit the value of the social network analysis approach. Using a qualitative approach to build diagrams by hand enabled analysts to give an 'overall impression' of the network some time before work was completed. Analysts could also use their experience to identify particularly important individuals which was felt to be important when 'quick' responses were required. However, this relies on building up local knowledge and expertise and, as can be seen from the networks, may lack some of the wider connections within the community.

Use of police intelligence data

Finally, one of the key tenets of the study was to see whether social network analysis with police intelligence data, rather than crime logs, could help improve the local picture of a gang. The prominence of non-criminal links within the dataset seems to suggest there is merit in this and the validation exercise found results were broadly in line with operational experience. However, the fact that the accuracy of police intelligence data is uncertain and is influenced by operational activity does need to be borne in mind when interpreting results. For example, a lack of intelligence on an individual does not necessarily mean they are not important to the network and vice versa.

Police representatives felt the network analysis approach would work best when used in combination with knowledge of the situation 'on the ground' (i.e. the analysis shone a light on the intelligence picture). But it did not easily provide conclusions if used in isolation due to the nature of the data. In light of this, it was suggested that the social network analysis could be used in tasking meetings to provide a strategic overview, and to review the completeness of police intelligence. This approach may also be a useful way to identify gaps in local understanding of urban street gangs and through this improve problem-solving analysis overall.

Discussion

This study demonstrates the potential for using social network analysis in building a nuanced understanding of a local gang problem, for systematically mapping data on individuals who may be involved (including non-crime data), and for targeting police activities. The approach provided valuable information to identify individuals who could be described as gang associated; to identify and understand gang activity; and to develop an understanding of the form and organisation of gangs. It did this in a systematic and objective way.

It is important to note that the individuals identified in this study would not necessarily see themselves or be seen by others as 'gang members'. By using intelligence data and looking at links between individuals who were not crime or gang related, the analysis shows how the gang sub-network is part of a much larger community. As many of the links between individuals are not unique, police activity may have a limited impact as networks may be able to 'mend' or alter due to a sub-structure of other relationships. Being able to visualise the connections may help police officers in deciding where best to target police activity. It can also help identify individuals potentially vulnerable to gang activity.

Using intelligence data to map networks had advantages and disadvantages. On the plus side the extensive network of links between individuals that were not crime related can be useful for planning police activity. It also helped identify people potentially vulnerable to gang association and it found a link between two known gangs in the area that the police had suspected but did not fully understand.

However, there were limitations to using intelligence data. The volume of records on an individual may indicate a genuine higher level of activity but it could also be the result of increased attention from the police. This is difficult to disentangle within the network but highlights how important it is to interpret findings in light of local operational experience and knowledge. The quality of the intelligence data can be variable and may create a potentially false impression of the situation (e.g. not specifying whether crimes were committed with someone or for them). So, there may be value in looking to supplement police data with information from other community safety partners in order to build a more detailed picture of what is known, and recorded, locally about a gang problem.

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Section A: Police intelligence

Police intelligence may be gathered routinely through operational policing activity, volunteered by members of the public, or collected as part of a purposive (tasked) information gathering activity. Sources include: victims and witnesses, communities and members of the public, prisoners, CCTV or Automatic Number Plate Recognition, covert operations, the media and internet, and commercial/statutory/non-statutory agencies.²²

Police intelligence data is collated into 'logs' which are completed by officers and undergo a quality assurance process by central intelligence teams. Each log has a unique identifier, the date of recording, a description of the intelligence (generally a few short phrases), a list of individuals involved, other factors that may be pertinent (e.g. crime reports), and the intelligence grading. The logs can be searched for named individuals, that provide all the intelligence logs connected to them. But, did not allow for these to be further subdivided into particular sorts of information (e.g. vehicle-related, drugs-related, etc.)

Grading of police intelligence

Police intelligence logs are categorised into a '5X5X5' grading, according to the professional judgement of the officer recording the log and subsequently intelligence units (following ACPO, 2010). Table A1 provides a summary of the categories.

22 ACPO (2007). Introduction to intelligence-led policing. Available online:
<<http://www.acpo.police.uk/documents/crime/2007/200708-cba-intelligence-led-policing.pdf>>

Table A1: Police intelligence grading

Source	Intelligence / information	Security / handling
A – Always reliable	1 – Known to be true without reservations (e.g. CCTV)	1 – Default
B – Mostly reliable	2 – The information is known personally by the source but not to the person reporting	2 – Permits dissemination to UK non-prosecuting parties
C – Sometimes reliable	3 – The information is not known personally to the source but can be corroborated by other information	3 – Permits dissemination to (non EU) foreign law enforcement agencies
D – Unreliable	4 – The information cannot be judged	4 – Permits dissemination within origination force/agency only
E – Untested source	5 – Suspected to be false	5 – Permits dissemination but receiving agency to observe conditions as specified

The analysis presented in this study focuses on intelligence above source grade B and intelligence / information above grade 2 (with security / handling grades 1, 2 and 3 – for security reasons, handling grades 4 or 5 were not available to access).²³ The decision to omit some intelligence was taken in consultation with police intelligence analysts, who advised that this was the most reliable information from the logs; although it is recognised that intelligence from untested sources (i.e. grading E) may be the most operationally important. This meant that codes A 1 to 4, B1 and B2 were included. All available intelligence logs were, however, coded, and in the end, very few links were actually lost through restricting the information for analysis (see Table A2). Overall, approximately 73 per cent of the available links were used in the analysis.

Table A2: Intelligence grading and number of links recorded

	All grades*	E, 1 to 4	D, 1 to 4	C, 1 to 4	B, 1 to 4	A, 1 to 4
Number of links	582	92	0	21	467	1
Proportion of all links	100%	16%	0%	4%	80%	<1%

* One log was not graded in the coding due to a data entry error, and was omitted from the analysis

Section B: Social network analysis software

There are several different network analysis software packages available. Two were used in the course of this project: UCINET²⁴ and the Node XL²⁵ package for Microsoft Excel (data was initially analysed in UCINET, and analysis was re-run in Node XL). All the charts in this report

23 In the event, none of the logs that were available (i.e. potentially 1-3) were graded above security / handling code 1.

24 Borgatti, S.P., Everett, M.G. & Freeman, L.C. (2002). *Ucinet for Windows: Software for Social Network Analysis*. Harvard, MA: Analytic Technologies.

25 Social Media Research Foundation, <<http://nodexl.codeplex.com/>>

were produced using Node XL, an open source package.

For UCINET, the collected data was converted into a format that could be read by the software via a Blitzbasic²⁶ routine. The networks produced were then visualised in NetDraw.²⁷ This was not needed for Node XL, which is able to read in data that is not in matrix form.

Section C: Comparing the results to local experience

Findings from the network analysis were shared with operational police representatives and police analysts in Greater Manchester to help validate the findings. A summary of some of the main points discussed are in Table A3.

Table A3: Views on findings of analysis

Analysis findings	Summary of views
The urban street gang was non-hierarchical	Confirmed by operational experience, although the ability of police intelligence to show hierarchical relationships in general was questioned (see below).
The entire community mapped was quite large, and not all explicitly gang-related	Felt to be an accurate representation of the picture – gang membership was seen to be fluid, with quickly changing affiliations. Some individuals were seen to be at risk of involvement in criminal activity.
Some individuals appeared highly connected in the networks when all the links were considered together, but not when only crime links were considered	Seen to correctly emphasise that looking at crime alone would not provide the information needed to plan effective action.
Highly connected but not crime-linked individuals were identified in the analysis	This was seen to reflect the potential for people on the periphery of criminality to be drawn into crime. The inclusion of non-crime links was seen to be promising for identifying potentially at-risk / vulnerable people.
Particular individuals had certain profiles in the networks.	Confirmed in most cases, but some individuals' precise role not known so not possible to validate. The analysis therefore provided additional useful information. Some issues were identified with the profiles which highlights the need to consider these along side the intelligence data and operational experience. E.g. one gatekeeper had family connections to a 'known' gang member but was not in the gang. They were therefore seen more as a candidate for safeguarding.

26 See <<http://www.blitzbasic.com/>>

27 See <<https://sites.google.com/site/netdrawsoftware/download>>

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