Detecting and disrupting criminal networks
A data driven approach
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Chapter 3

Bridging science and investigative practice
The application of social network analysis in criminal investigation

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ABSTRACT

Objective: Social network analysis (SNA) is conquering its place in criminological tradecraft, with an emphasis on conceptual contributions in current Dutch criminology. Meanwhile, the domain of criminal investigation and intelligence witnesses the emergence of a flourishing SNA practice. The academic and investigative domains have largely remained separated, with analysts borrowing from cutting-edge methodological scholarship while giving little in return. Their classified products remain inaccessible to academic researchers. This article endeavors to bridge the two worlds.

Method: Systematic review of SNA studies aimed at various criminal networks. These studies are performed by law enforcement analysts working for the Dutch Police. Additionally a survey was taken from the responsible analysts about the use of SNA within their professional environment.

Network data: meta-analysis of 34 criminal networks

Results and conclusions: Although it has much potential, an important limitation of SNA is that it mainly provides a static observation of a dynamical phenomenon. Subsequently the application of SNA has mostly been limited to criminal networks observed on a micro-level. For more deliberate targeting of criminal networks we need a better understanding of its macroscopic patterns of resilience and the dynamics that fuels its typical complex adaptation over time.
3.1 INTRODUCTION

Like in many other countries, major organized crime investigations in The Netherlands at least until the early 1990s focused on the supposed leaders of perceived mafia-like pyramidal organizations. Gradually criminologists with access to empirical data began to question the pyramid paradigm, indicating, inter alia, the importance of social network structures (Kleemans et al 1998; Van de Bunt et al 1999; Klerks 2000a, 2000b, 2001). Intensive criminological research began to expose the dynamics of organized crime with its constantly changing roles and positions, often resulting from local social structures such as neighborhoods, schools or sports clubs (Spapens 2006; Kleemans & De Poot, 2008). This resulted in recommendations for other types of crime control, such as the integrated approach involving the mobilization of other government agencies like municipalities and fiscal investigators. In practical crime control however, such innovative criminological concepts are only gradually changing traditional beliefs (Spapens 2006; Huisman et al. 2011; Duijn 2013).

Social network analysis

We proclaim that social network analysis (SNA), a systematic method to analyze networks of individuals, has the potential to bring science and investigative analytical practice closer together (Scott & Carrington 2011). SNA requires the processing of relational data in matrices and graphs (Hanneman & Riffe 2011). This forms the basis for specific quantitative and qualitative analytical techniques. For quantitative analysis, relational data are processed in a matrix table, wherein all the persons in a network are placed on the rows and columns. In the matrix, the presence of a relationship between the players is designated by ‘1’ and the absence thereof with ‘0’. With this incorporation of all relational data in the matrix, a digitized version of the network emerges, the characteristics of which can be calculated by means of algorithms. Additional qualitative analysis is possible based on the specificities (attributes) of individual actors. These attributes are also processed in a matrix in which the players are placed on the y-axis and their attributes on the x-axis; the presence of an attribute for any actor is indicated by ‘1’ and the absence with ‘0’. For qualitative analysis, this matrix is read into a visualization program for creating relational diagrams (graphs). Here the actors and relationships are presented, while specific characteristics of actors can be distinguished by color or shape and can be combined. For example, by combining the attribute gender with the quantitative results for centrality, the relative position of women in a criminal network can be analyzed. The visual representation of relationships, actors and attributes allow for the interpretation of abstract mathematical results in their context: the qualitative analysis is thus complementary to the quantitative analysis.11

11 Cf. Scott (2013) and Scott & Carrington (2011) for an extensive explanation of SNA methodology.
of the entire network, specific subgroups and features of individual actors can thus be distinguished and associated with each other. Many criminologists have begun to apply SNA to gain insight into criminal or terrorist network structures (Klerks 2001; Krebs 2002; Natarajan 2006; Morselli 2009, 2014; Calderoni 2014; Duijn & Klerks 2014).

Analyzing criminal cooperation through the visualization of suspects in relation to criminal offenses and accomplices is a common research method (Van Hartskamp s.a.; Fijnaut & Moerland 2000; Klerks 2000a, 2000b). The difference between this ‘traditional’ form of criminal group analysis and social network analysis is firstly that SNA uses advanced concepts and algorithms to visualize interdependence and influence. This approach reveals that supposed leaders do not always determine the strength and continuity of the network. Where the offender group analysis focuses on criminal behavior, SNA looks to broader social embeddedness of criminal cooperation and the often multi-dimensional nature of relationships. Finally, offender group analysis has only limited concern for individual traits, characteristics and skills of actors, while SNA applies such attributes precisely to gain deeper understanding of the cohesion, strengths and weaknesses of a network. Since the widely used analysis package Analyst’s Notebook (AN) has begun to offer some basic SNA features, offender group analyses have shown a methodological development. AN now allows the calculation of some basic centrality measures, but the responsible application and interpretation of this requires a solid training in SNA.

Interest in SNA within the police dates from the early nineties (Sparrow 1991; Klerks 1994, 2000b). The Dutch Police Academy has developed and propagated SNA through research and seminars. Since 2008, the course “Applying Social Science in Social Network Analysis (SWISNA)” has been part of the Criminal Science curriculum. Over 19 weeks, the SNA method is learned and enriched by a social science perspective on human relations and (criminal) cooperation. The demand for such a training is fueled by the greatly increased availability of data (big data). Traditional information from police registers, complemented with data from open sources and social media becomes increasingly important for understanding deviant network structures (Dijkstra et al 2013). SNA allows for making smart selections from this flow of information, which are qualitatively reworked into intervention proposals. The SWISNA training produces a variety of exam papers in which SNA is applied to practical cases, from problematic youth groups to criminal and extremist associations. These papers and various practical experiences show that SNA allows concrete recommendations for alternative intervention strategies to combat crime.

Dutch criminologists still appear reluctant to apply SNA methodology, focusing instead on underlying theoretical concepts. While their insights may inspire the practical application of SNA by analysts, the lessons thus learned are rarely fed back into the academic realm.
Outsiders might assume that the sensitivity of the data used stands in the way of greater academic involvement in investigative SNA practice. However, the interaction between investigators and academics is more intensive in The Netherlands than elsewhere, thanks to the seminal work of the research-group of Fijnaut (Fijnaut et al 1995). The fact that Dutch criminologists rarely apply SNA, seems to be a more important factor. For the moment, there appears to be little to gain in methodological support and conceptual progress from academic involvement.

From our position at the cutting edge of investigative practice, policy and research, it seems useful to provide insight into the current application of SNA within the police. Thus, we attempt to identify where the two worlds can be brought closer together when SNA bridges the gap between science and criminal investigative practice. This requires answering four questions:

1. How is SNA used in the investigative practice?
2. Which restrictions are experienced in this use?
3. To what extent are these practices grounded in scientific theory?
4. Are the insights thus gained applicable in criminological science?

Systematic analysis of current SNA practice should yield some answers. Our research remains exploratory and descriptive; only some aspects, such as the applicability of SNA algorithms to specific crime problems, allow for preliminary explanations. We do interpret our research findings wherever possible.

First, we describe the empirical material used: 34 exam papers, and 8 theses from students at the Police Academy of the Netherlands, plus 28 responses to a survey on operational use of SNA obtained from SNA-certified Dutch police analysts. This is followed by the analytical framework, findings on the use of sources, network boundary definition, data analysis on three network levels, forms of qualitative interpretation and findings concerning the overall applicability of SNA. In the concluding Section we discuss differences between SNA application in the investigations and the intelligence environment, possible connections with the scientific domain and future prospects, including the exploration of big data.

### 3.2 SOURCES AND METHODOLOGY

To answer to the problem, we commenced with a study of relevant literature. An extensive search in scientific literature databases produced studies on the application of SNA in the security domain. The insights thus collected have been used for constructing an analytical framework, as well as for synthesizing the findings from the material under study. This empirical material consists of the following sources:
Examination Papers from the Social Network Analysis course: the first empirical source consists of exam papers of the (partly very experienced) students who attended the SWISNA course module at the Police Academy between 2008 and 2014, and completed the course with the application of SNA on a practical case study. The educational team for Intelligence responsible for the SNA training identified 35 papers (N=35) as relevant for answering our research questions. In this selection process, the papers were examined for quality and relevance. Despite their primary operational focus, almost all examination reports contain recommendations regarding the practical applicability of SNA. Following this preselection, all remaining 35 papers were found sufficiently relevant to be included in our research.

The second criterion was the quality of the papers. The students are tested by an independent board of examiners consisting of two SNA experts from the field. The exams evaluate research design, data collection, analysis, synthesis, scientific substantiation and the conclusions and recommendations. To ensure the quality of this empirical material, solely those reports evaluated as ‘sufficient’ or better have been included in this study. Finally, all the students were personally requested to seek permission for the use their paper. Only one of the reports was withheld for security reasons involving ongoing investigations, bringing the number of available reports for this study at 34 (N=34).

Analysts working within law enforcement are involved in various disciplines. Some are spiders in the web of criminal investigations. Others operate in the first phase of the investigative process preparing intelligence reports, project proposals or integrated intervention strategies. Yet others play a role in public order maintenance, focusing on nuisance by youth groups of violent soccer hooligans. Table 3.1 provides an overview of the central themes in the analyzed SNA papers.

12 By early 2014, almost 100 students had completed the SNA course. Part of the Proof of Competence is the writing of a paper in which social scientific knowledge and the SNA method are applied on a problem in the context of a criminal investigation. These research papers are written by groups of 2 to 4 students and number about 40 pages plus addenda. The end of 2013 had presented 40 papers for examination.

13 Forming a well-founded opinion on the applicability of SNA was part of the examination assignment of the SNA course.

14 The exam papers used for his research are listed in the first part of the Sources list and identified by a number plus the central theme of the paper. Since all these papers are of a confidential nature, the authors and further details have been withheld.
Table 3.1: Classification of analyzed SNA papers (2009-2014)

<table>
<thead>
<tr>
<th>Theme</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organized Crime</td>
<td>15</td>
</tr>
<tr>
<td>Organized cannabis cultivation</td>
<td>7</td>
</tr>
<tr>
<td>Cocaine import</td>
<td>4</td>
</tr>
<tr>
<td>Synthetic drugs</td>
<td>2</td>
</tr>
<tr>
<td>Human trafficking</td>
<td>1</td>
</tr>
<tr>
<td>Money laundering</td>
<td>1</td>
</tr>
<tr>
<td>Youth groups</td>
<td>9</td>
</tr>
<tr>
<td>Cold cases</td>
<td>6</td>
</tr>
<tr>
<td>Corruption</td>
<td>2</td>
</tr>
<tr>
<td>Illegal fireworks trafficking</td>
<td>1</td>
</tr>
<tr>
<td>Vehicle theft</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>34</strong></td>
</tr>
</tbody>
</table>

**Survey:** to gain insight in the actual use of SNA by the analysts following the completion of their training, a survey by e-mail was held among all SNA-certified police analysts. 28 respondents from all branches supplied information on their practical experiences with SNA. These answers are also used as a source for this study.

**Master theses in Criminal Science:** some Criminal Science students chose an SNA-related subject for the final course on *Scientific Expertise and Investigation* (WEO). Through the snowball method, the network of investigative experts and Police Academy teachers located a total of eight relevant theses. These include empirical observations concerning the application of SNA in criminal investigation and address implications for SNA as a bridge between investigations and science.

**The analytical framework**

For systematic analysis of the exam papers, an analytical framework was drafted (Table 3.2), consisting of the elements characteristic for SNA. These elements correspond with the successive phases of the SNA method. Thus, successively the theme, problem formulation, considerations regarding sources used, network demarcation and matrices were analyzed.

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15 These theses concerned three different aspects of SNA. Firstly, the application of SNA on a specific crime problem: Van Eck (2013) on SNA in human smuggling; Lansbergen (2014) on SNA on Chinese criminal networks in Holland; Van der Putten (2013) on women in synthetic drugs networks. Secondly, the applicability of SNA within a police task: Anonymus (2013) on SNA’s applicability for the Criminal Intelligence Unit, and Bosveld (2010) on Forensic SNA in cold cases. Finally, the elaboration of a specific SNA concept: Van Dijken (s.a.) on key players in criminal networks; Boogers (2010) on brokers in cannabis cultivation; Visser (2013) on the effects of an intervention on a criminal network.
for each paper separately. This approach was chosen because the results and conclusions of a social network analysis are determined by the irreversible methodological paths chosen in earlier successive phases of an SNA. Understanding why certain actors emerge as central players, for example, requires knowledge of the grounds on which the network boundaries were chosen in an earlier phase. In order to further specify such explanations for specific cases, a differentiation between the separate elements is necessary. This also benefits the connection to science. For example, this allows for an examination of the extent in which scientific principles of reliability and validity underlie practical SNA applications. The four final elements of the analytical framework also contribute to this. All elements of the analytical framework have been further operationalized in Table 3.2.

Table 3.2: Elements in the analytical framework

<table>
<thead>
<tr>
<th>Operationalization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Theme</strong></td>
</tr>
<tr>
<td><strong>Theoretical basis</strong></td>
</tr>
<tr>
<td><strong>Problem formulation</strong></td>
</tr>
<tr>
<td><strong>Sources used</strong></td>
</tr>
<tr>
<td><strong>Network boundary specification</strong></td>
</tr>
<tr>
<td><strong>Matrices used</strong></td>
</tr>
<tr>
<td><strong>Quantitative methods</strong></td>
</tr>
<tr>
<td><strong>Macro level (Network)</strong></td>
</tr>
<tr>
<td><strong>Meso level (Subgroup)</strong></td>
</tr>
<tr>
<td><strong>Micro level (Actor)</strong></td>
</tr>
<tr>
<td><strong>Other quantitative</strong></td>
</tr>
<tr>
<td><strong>Application of Scripting</strong></td>
</tr>
<tr>
<td><strong>Application of Visualization</strong></td>
</tr>
<tr>
<td><strong>Qualitative analysis</strong></td>
</tr>
<tr>
<td><strong>Conclusions and recommendations</strong></td>
</tr>
<tr>
<td><strong>Limits</strong></td>
</tr>
<tr>
<td><strong>Practical value</strong></td>
</tr>
<tr>
<td><strong>Scientific relevance</strong></td>
</tr>
<tr>
<td><strong>Remarks</strong></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

For the analysis of all elements for each paper an Excel-matrix was used, in which the elements are placed on the columns and the individual exam reports on the rows. For

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16 In accordance with the chronological SNA method described in Scott (2013) and Wasserman & Faust (1994).
each of the papers, the findings relating to each element are described in the matrix. This structured overview allows for comparisons between papers (on the rows), but also between elements (on the columns). This has two advantages. Firstly, papers can be filtered on specific themes. Because the papers are exploratory in nature, the techniques used can vary greatly. By filtering on a theme, the effect of different approaches on the final result become clear and best practices for each theme come to light. Secondly, correlations between individual elements are easily identified. The matrix for example allows for the analysis of how the element ‘network demarcation’ can account for varying results on macro level analyses. Details of specific applications, considered in a wider context, allow for conclusions on the practical applicability of SNA and to the identification of elements that are influential.

3.3 RESULTS

For a systematic analysis of the exam papers, Section 3.1 discusses their theoretical basis, after which Section 3.2 considers the sources used. Section 3.3 deals with coding, network demarcation and building matrices. Section 3.4 discusses the analysis from the SNA methodology, as well as the qualitative interpretation. Finally, in Section 3.5 the applicability of SNA is examined.

As described above, the exam papers are analyzed on the basis of the elements given in Table 3.2. In the element ‘Problem formulation’, we distinguish three perspectives. Some of the papers focus on applicability of SNA to arrive at new operational insights. Others explore the overall network structure to come up with recommendations. Yet others restrict themselves to formulating an operational problem, focusing on identifying actors suitable for effective interventions or further investigation. The formulation of the problem proves a crucial stage in the analysis process. Problem stipulation and research questions set the framework for the analysis that follows, including the selection of sources, network delineation, quantitative measures and qualitative interpretation.

Theoretical basis

Social network analysis as a research method for social reality is scientifically based and constantly tested and expanded. Nearly every SNA exam paper refers to SNA handbooks such as Scott (2013). The use of SNA is often argued with theories on social capital (Burt 2001), weak relationships (Granovetter 1973) and other familiar SNA-related concepts.

Furthermore, all the authors apply scientific knowledge and concepts relevant to the central issues in their papers. We find references to literature on juvenile crime, specific deviant
subcultures and forms of crime. The application of SNA methodology and interpretation of the results in the light of social scientific insights form the paper's core. Students construe explicit relationships between their investigative practice, SNA and science, in particular criminology.

**Sources used**

Departing from their problem stipulation, students choose from a variety of sources. The selection of sources has a significant impact on the final results and conclusions of a social network analysis. Each type of source has advantages and disadvantages. Table 3.3 shows the sources that lie at the basis of the papers.

**Table 3.3:** Number of papers using specific source types (broken down by theme)

<table>
<thead>
<tr>
<th>Source Type</th>
<th>Org. crime</th>
<th>Juvenile groups</th>
<th>Cold cases</th>
<th>Corruption</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed sources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Witness statements</td>
<td>13</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Suspect statements</td>
<td>13</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Wiretap reports</td>
<td>14</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Telecom logs</td>
<td>14</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Surveillance reports</td>
<td>5</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Patrol/Incident-reports (‘Blueview’)</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Criminal intelligence</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Interviews</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other closed sources</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Open sources (social media)</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Unknown</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
<td><strong>9</strong></td>
<td><strong>6</strong></td>
<td><strong>2</strong></td>
<td><strong>2</strong></td>
</tr>
</tbody>
</table>

**Investigative data**

The majority of the analyzed papers is based on data from investigations, such as witness statements, investigative interviews and telephone transcripts. SNA on wiretaps may relate to two sources of relational data: the metadata (so-called histo’s with communications traffic data: which subscriber numbers have had contact, who is the initiating party calling in, when, how long and possibly from which location or quadrant) and the content report (Verhoeven 2009). With few limitations, SNA can be applied to the traffic data. This has proven to be particularly valuable when analyzing large networks and/or longer periods, as it can be difficult to determine the relevance of tens- or hundreds of thousands of contact items. The SNA papers demonstrate that intercept reports can be a very rich source of firsthand information about criminal, but also social contacts. They provide insights into the way in which actors interact and often in the roles and hierarchy. However, these data
are obtained mainly from the viewpoint of evidence. Investigators often assess social talk as irrelevant which, if observed through the SNA lens, may contain interesting indications (Sparrow 1991; Klerks 2000a; Morselli 2009). Many students therefore chose to reassess and code the intercepts. In most of the papers, this led to unique insights into the functioning and stability of criminal network structures and the important role of the surrounding social network of family and love relationships, friendships or membership of an association (such as an outlaw motorcycle gang).

Such insights generate innovative operational and strategic recommendations, but the students also address the limitations of the usability of criminal investigative data for SNA. Firstly, the information available on the actors within a network is often unbalanced due to the objectives of the investigation. The evidence gathering after all is focused on one or more (main) suspects, who will thereby show up more prominently in a network reconstruction. Secondly, with intercept reports there may be a reliability problem when criminals suspect that they are being intercepted. Disinformation or guarded conversations may affect the reliability of the eventual network composition. Thirdly investigative information may be interpreted subjectively or incorrectly, when misleading or code language is used in intercepted telephone conversations. Such interpretations depend on the investigator’s personal perception and experience. Fourthly, the investigative information is often outdated, which limits the usefulness of recommendations for the current practice. Finally, investigative information provides a predominantly static image, while criminal networks are dynamic in nature. Later on, we will discuss possibilities to correct for such biases.

Sparrow (1991) and later Verhoeven (2009) already suggested that in a final network presentation based on investigative information, suspects whose communications have been intercepted will always come out in central positions. To what extent then can SNA, based on investigative data, still contribute to new insights? While taking into account such limitations, students still sought for possible value. As should be expected, this search did not yield new insights into the positions of prime suspects, but it can shed new light on how the immediate periphery organizes itself around those central actors.

With evidence collection on the main suspects as the primary goal, it is logical that the periphery in many investigations gets less attention. Some groups of students therefore focused explicitly on the periphery of the ego network (e.g., papers 3, 6, 12, 15 and 34).

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17 To reduce bias due to differences in interpretation among coders, students in the SNA course are taught to apply a consistency analysis on the actual coding of intercept reports. Two or more students simultaneously analyze an identical data set and afterwards note the differences in interpretation. These differences are recorded in a coding journal that serves as a guideline for further coding.

18 Egocentric networks consist of all direct relations of one actor, referred to as ‘Ego’ (Scott and Carrington 2011).
This can for instance lead to a better understanding of the importance of women to the resilience of criminal cooperation. Although they are not always directly involved in criminal activities, women in some networks contributed to internal conflict resolution or brought in outsiders as reliable replacements after a crucial actor had disappeared (papers 1, 11 and 21). One of the papers illustrates the significance of transfer between generations: the offspring of the central criminal actors had assumed brokering positions in the periphery of a criminal network (paper 11). The students concerned suggested an explanation built on Sutherland’s (1939) theory of social differentiation, pointing out that criminal activities may be transmitted from father to son. Another group of students took the continuity of the periphery as a starting point and examined two investigations focused on the same Ego. The data came from one investigation that was done before Ego was arrested, and one investigation held a year later after Ego was taken into custody (paper 15). Changes in the composition of the periphery were observed, from which new actors could be identified for further investigation.

Investigative information was also chosen by other researchers as a source for scientific SNA applications. Morselli (2009) researched the Canadian ‘Caviar’ network, on which multiple interventions were executed over a longer period. Investigative science student of the Dutch Police Academy Visser (2013) considered the effects of repeated police interventions on a Dutch network of bank fraudsters and established that the modus operandi after arrests were readjusted, so that the criminal activities could be continued almost instantly. Remaining network members attempted to become invisible to the police. Evidence was made to disappear, cellphones were discarded and protagonists urged their contacts to no longer address them as “boss” and moved to the background. Suspects who after their pre-trial detention returned to the criminal network, lost their centrality in SNA terms and ended up in the periphery.

Van der Putten (2013) examined the role of women in synthetic drugs networks from a social network perspective, again based on investigative data, and found predominantly wives, girlfriends or mistresses of criminals. Women fulfilled various roles in the supply chain, but most remarkable was their position change once the male protagonist disappeared. “They then act as an intermediary, facilitating, passing along information, bringing others into position organize practical matters”. Van der Putten also mentions several examples of wives and daughters who run the criminal enterprise on behalf of the criminal protagonist, doing business on his behalf. Van der Putten states that this important role of women is still not recognized by prosecutors and law enforcement officers. Female care-

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19 Van der Putten’s empirical material came primarily from an extensive analysis of police registers, combined with interviews with police and other experts, as well as a survey among criminal informants with insider knowledge of criminal networks.
takers are often not prosecuted and they are six times less likely to receive an unconditional conviction compared to males for similar offenses. It is partly through this mechanism that criminal activities and structures can be maintained for prolonged periods.

In all these case examples the quantitative SNA of the raw data pointed out interesting elements of network structure and composition that were subsequently qualitatively analyzed. Quantitative and qualitative analysis were complementary and facilitated seeking rather than assuming structure.

**Enforcement information**

Some students chose to compensate for the bias of investigative information by combining data sources. An important additional source of information is enforcement data, mainly consisting of patrol and incident reports made up by street officers. Table 3.3 shows that such enforcement information was used mainly for studying juvenile groups. Often, community-policing officers were interviewed to enable further interpretation of system information. The emergence of the intelligence-led policing doctrine and practice has made frontline officers more aware of their task of contributing information. This is achieved e.g., through briefings urging personnel to actively collect information on specific problems in order to determine an intervention strategy. Thus, information is collected about specific members of juvenile groups and their position in the group (Duijn & Klerks 2014). This simplified the network reconstruction for a number of papers.

However, such enforcement information also has certain disadvantages for SNA. What police officers perceive is partly determined by which incidents occur during their shifts in the area, which produces a special form of selection. Also, not all observations are registered, due to time constraints or perceived lack of relevance. Furthermore, observations are selective in nature: the most visible actors in the streets can be hangers-on and wannabees, while core members remain less noticeable in the background. One group of students attempted to have three community policing officers score on an actor by actor matrix, based on their knowledge of a youth group. Their scores of each particular relationship, when compared with the information from police registers, appeared to be based too much on assumptions. The input of the community police officers proved more useful as background knowledge from a historical perspective (paper 30).

**Human Intelligence information (HUMINT)**

In addition to investigative and enforcement information, there is human intelligence information (HUMINT). The gathering of criminal intelligence by handling informants is organized within the Teams Criminal Intelligence (TCI) of the Collection department at every Police Unit (Van der Bel et al. 2013). For SNA applications, criminal intelligence information
has a major advantage: it is collected for the purpose of building an information position, relatively independent of criminal investigative or enforcement objectives. Provided that the analyst has access to the handlers who gather the information, the gathering process can be tasked for SNA-specific aspects by asking particular questions about roles, tasks and social aspects, or by requesting to seek out new informants.

A disadvantage is that the information that is collected may only be used if it does not compromise the informant’s anonymity. From most raw informant debriefing reports, only a few chunks of shareable information remain (Vis, 2012). Nonetheless, several pieces on different network actors, once combined, may offer a unique perspective on a network compared to investigative or enforcement information. Access to intelligence information, however, requires an additional authorization which not all analysts possess. This may explain why intelligence information was used in only five of the exam papers (Table 3.3). Intelligence information can be sanitized for use in SNA by substituting all data on individuals using an encryption code. Duijn et al. (2014) for example built their study on interventions on criminal networks partly on anonymized criminal intelligence data. This University of Amsterdam study provided a best practice for criminal intelligence work, thus demonstrating that intelligence data are not entirely inaccessible for scientific SNA purposes.

**Social Media**

Finally, two papers also looked at information from open sources, in particular social media. In paper 33, only one actor from a population of fifty people was found to be active on social media. The students saw a relationship with the age structure of this actor population, since social media use is less common among those over fifty years of age. A second group attempted to integrate social media information when reconstructing a juvenile group. Here the interpretation of such information posed a problem: mere occurrence in a list of friends on Facebook is inconclusive about the possible criminal nature of a relationship. Still, social media information is sometimes useful to supplement data from closed systems. This was illustrated by two actors in a criminal network who appeared intimately embraced in a picture published on social media with the caption “friends for life”, while their connection could not be discerned from police systems (paper 11). Based on such open source information, an assumed relationship can be added to the network in order to be verified through a more refined search in closed systems. Utilizing more than just investigative information can help to understand the social embeddedness of criminal behavior and open up a bridge to scientific analysis of crime and its causes.
Combining sources

When any separate data source in the criminal justice system has structural limitations, all network reconstructions based on criminal justice data will suffer from missing data. The challenge lies in attempting to approach social reality as optimally as possible, using the data that are available. For this, Morselli (2009) has introduced a useful classification framework (Figure 3.1).

Figure 3.1: Visualization of the scope and accuracy of network data related to its origin in the different stages of the criminal justice chain (Duijn and Klerks 2014; Morselli, 2009)

In this framework, the broadest scope of the target network is achieved in the intelligence phase during which network operators are monitored, but are not yet the target of an investigation. The scope then decreases as the investigative phase starts and suspects may get arrested, prosecuted and convicted. Figure 3.1 shows that this leads to a more limited availability of sources, as a result of the legal requirements in successive stages of the criminal process. Conversely, Morselli (2009) emphasizes that the accuracy of the network construction will gradually increase. A legal sentence after all will be based on a judicial ruling founded on proven facts, implying a substantially higher degree of accuracy compared to data coming from criminal informants. Still, with only a judicial ruling as a starting point, the scope of a criminal network will usually be rather limited.20 The scope and accuracy

20 This does not imply that SNA based on court dossiers could never produce interesting results, as demonstrated by e.g. Bright et al. (2014). For researchers in quite a few countries, published court rulings are indeed the only accessible source of empirical data on organized crime.
of a criminal network reconstruction, according to Morselli (2009), are therefore inversely proportional to the use of sources from successive stages of the criminal justice process. He prefers data from the later stages of the criminal process, because the accuracy of the network composition is then secured.

Like Morselli (2009), many students focus on sources from the investigative stages of the criminal justice system, but they report major drawbacks because of the limited scope that this creates. Especially in papers that focus on a single investigation, the final conclusions come with a caveat. The student’s detailed knowledge of the files and their investigative expertise may be influential in their critical claim that the limited sources used result in a filtered image of the actors in the criminal network. A number of students suggest that combining different sources can provide a solution (papers 1, 11, 12, 13, 15 and others). Students see the best opportunity for this in the intelligence phase, when the legal context allows for such combinations of various data. Intelligence analysts may exploit surplus information from earlier criminal investigations, patrol and incident reports, and open sources, which once combined can compensate for the limited accuracy of each separate source. Comparison of network constructs based on single sources allow for the assessment of the reliability and accuracy of those particular sources. This ultimately results in a more valid and reliable reconstruction of the network under study. Furthermore, merging different data sources in a comprehensive relational database contributes significantly to an understanding of criminal cooperation and modi operandi across single criminal investigations, police regions and national borders. SNA can thus help to clarify links between local criminal networks and identify connecting key persons.

Matrix and boundary specification

After the identification and scoring of sources, the data are encoded in a matrix structure.21 All the analyzed exam papers use the actor by actor matrix to establish mutual relations. Frequently, different matrices have been created to distinguish between types of relationship (criminal, friendship, love) or kind of criminal activity. Different overlapping layers may bring new aspects of network structure to attention, such as the relationship between family ties and criminal cooperation. In a number of papers relating to organized crime, this leads to the identification of underlying social structures; in the caravan-dwelling community of (former) so-called ‘travelers’ for example, family ties often constitute the social framework in which various criminal networks are grounded (papers 11 and 12).

Another illustration of the value of distinguishing between types of relationships is found in the application of SNA on cold-case investigations (papers 18, 19, 23, 31, 32 and 33).

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21 An extended discussion of the relevant methodology is found in e.g. Scott & Carrington (2011).
Paper 19, for example, distinguishes between types of relationships such as love, mutual hobbies, neighborship and work colleagues. In addition to an overall matrix of all relationships, separate matrices were made for each type of relationship. By combining matrices, subgroups around the murder victim can be highlighted and compared for overlap. Using the Forensic SNA methodology (Spreen & Vermeulen 2008), students could identify individuals who were part of multiple subsets around a victim and could therefore have valuable information. Individuals fitting this profile who had not been interviewed earlier, can be prioritized as new witnesses upon the reopening of the cold case.

In addition to the standard actor by actor matrix, all the papers examined also applied actor by attribute matrices, in which actors are coupled with individual characteristics. Often the researchers opted for apparent attributes such as gender, location, age, suspect/no suspect, criminal record and so on. Highlighting the presence of certain attributes in network visualizations can produce interesting insights. Figure 2.6 (see p. 46) of the previous chapter demonstrated how the ‘gender’ attribute provides insight in the well-embeddedness of women in the information currents flowing through the particular criminal network. The visualization algorithm applied for this purpose places actors with many connections automatically in central positions in the diagram. Such visualization facilitates an initial exploration of the scored data. A further quantitative analysis of centrality measures (degree, betweenness, closeness, eigenvector etc.) is required before firm conclusions may be drawn.

With all the matrices filled, the network boundaries must be defined before starting the analysis. This demarcation can strongly influence the analysis results; an effect referred to as the boundary specification problem (Sparrow 1991; Van der Hulst 2008; Morselli 2009). It is therefore important to derive a criterion from the central problem posed, on which actors can be included. In the papers, the boundary specification and definition is invariably determined by the central research question. For research questions aiming at specific types of organized crime activities (e.g. migrant smuggling, counterfeiting, drug trafficking), students decided to delineate the network by actors with determent involvement in a specific criminal market. Sometimes the individuals formally considered as suspects form the starting point for inference of the core network, which is then further extended in numbers while the scoring of the data. The risk with this approach however, is that the network boundary becomes too wide. This approach should be followed by a point of assessment which actors to include or exclude in the final network representation following the central research question.
In cold-case papers the network composition is on average determined by all individuals emerging from witness statements.\textsuperscript{22} In one case, the first degree contacts of those initial network members, based on patrol and incident information, were also included. This led to the identification of previously unknown parties.

For juvenile groups, network boundaries are often determined by what was already known about the group, most often based on the shortlist approach (Ferwerda 2009). In these cases, the members of the juvenile group were taken as the starting point and their first degree contacts, based on patrol/incident information, was added to the network composition. In one case, the snowball method as described by Scott (2013) was applied on the patrol/incident database. This method is discussed in more detail in the next Section.

In nearly all of the papers under study, the students demonstrate awareness of the fact that network boundary specification determines the eventual results. In several papers, this artificial boundary specification is mentioned as a limitation to understanding the positions of the individuals in the network.

**The analysis**

After all the data have been scored and the network is demarcated, the analysis can be performed using the multitude of algorithms available to the SNA practitioner. To determine the most useful measurements, it can be helpful to distinguish three network levels:

1. characteristics of the overall network (macro);
2. characteristics on the subnetwork level (meso);
3. characteristics on the individual level (micro).

Many SNA specialists believe that individual characteristics of actors can only be properly interpreted if the general characteristics of the network in question are known (Baker & Faulkner 1993; Robins 2008; Morselli 2009). The three levels cannot actually be considered separately. This means for example that the benefit, which an individual actor can derive from a bridging position between two parts of a network (high betweenness score), can only truly be strategic if the embedding macro network has a low density (with overall few reciprocal links). This makes it of essential importance to continuously combine the understanding of three levels. In most of the papers studied, the three network levels and their interaction have been analyzed, as shown in Table 3.4.

**Analysis on system level**

Table 3.4 shows that on the macro network (systems) level, \textit{density} is the measure most often used. Density indicates how the total number of observed connections relates to the theoretical maximum number of possible connections in the entire network, which says

\textsuperscript{22} This is in accordance with the Forensic SNA methodology developed by Spreen & Vermeulen (2008).
something about how easily actors can reach each other and how fast information can be disseminated. Several criminologists have concluded from research that criminal and terrorist ‘dark networks’ constantly have to balance between efficiency and secrecy (e.g. Morselli et al 2007). Complicated criminal business processes require effective communication to allow for deployment of specific actors at the right time. On the other hand, communication involves risks of discovery by investigating government agencies or rival criminals (Baker and Faulkner 1993; Morselli et al 2007; Lindelauf et al 2009). The density analysis indicates how the balance passage within a network for efficiency and secrecy. The geodesic distance indicates the average number of steps in which all players can reach each other.

Table 3.4: SNA measures by theme

<table>
<thead>
<tr>
<th>Macro network</th>
<th>Org. crime</th>
<th>Juvenile groups</th>
<th>Cold cases</th>
<th>Corruption</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centrality</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Density</td>
<td>11</td>
<td>8</td>
<td>5</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Geodesic distance</td>
<td>8</td>
<td>3</td>
<td>0</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Subnetworks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clique analysis</td>
<td>11</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>K-core</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Clan analysis</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Qualitative</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Individual positions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree</td>
<td>15</td>
<td>9</td>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Closeness</td>
<td>15</td>
<td>9</td>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Betweenness</td>
<td>15</td>
<td>9</td>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Eigenvector</td>
<td>7</td>
<td>6</td>
<td>4</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Bonacich power</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Keyplayer 1</td>
<td>5</td>
<td>6</td>
<td>-</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Keyplayer 2</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Structural holes</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Scripting</td>
<td>13</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Visualization</td>
<td>15</td>
<td>9</td>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>9</td>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Visualization of an entire network can help in interpreting the network structure. In most of the papers, the total structure based on the actor by actor matrix is displayed in a sociograph. A limited number of papers disregards the characteristics of the overall network;
the focus is then on ego-networks, especially in cold case networks where the victim is the central focal point. In these cases, analyzing the total network has little added value.

**Analysis at subnetwork level**

Once the big picture has been made clear, the analysis can shift to substructures within the network. For this, again, multiple approaches are possible. Identifying subnetworks had added value when applying SNA in criminal investigations. In organized crime for instance, it enables identification of clusters of people specializing in certain phases of the criminal logistical process. Papers on juvenile crime groups demonstrate that with the **core sequence collapse** or **K-core** analysis, the core of such groups can be identified. In cold cases, identification of subnetworks around the victim may provide new paths of investigation. In a number of cases, sub-networks have been identified through qualitative analysis based on attributes of edges (e.g. family tie, intimate relationship, teammates in sports, working relationships).

Table 4 shows that clique analysis was the measure most often used for identifying subnetworks. Clique analysis constitutes a strict delineation of a subnetwork; a clique consists of actors that are maximally connected to each other. In most papers, clique analysis produces a multitude of subnetworks. These are sometimes related to analysis at the individual level, as actors appearing in multiple cliques can occupy central network positions. The less commonly used core collapse sequence has proven to be very valuable for distinguishing the network core from its periphery.

The exam papers restrict themselves mainly to basic techniques when discovering substructures in larger criminal network structures, such as cliques and K-cores. One investigative science student of the Police Academy specifically focused on the identification of more advanced SNA techniques that could contribute to identifying subnetworks in a complex criminal network based on intelligence information ([Anonymous] 2013). In this research, a total of seventeen SNA measures were tested for their applicability in identifying meso networks. Three measures were found particularly suitable: HiClus, HiClus + NewmanCommunities and GirvanNewmanPartitions (Girvan & Newman 2002). The manner in which these measures managed to bring clarity in a very sizeable intelligence database made the researcher to conclude that: “Without SNA it is virtually impossible to identify the various meso-networks in the macro network”.

**Subnetworks within juvenile groups**

Because relatively many of the analyzed papers (N = 9) involved the application of SNA on juvenile criminal groups, we can come to establish a **best practice**. As already mentioned, the papers often departed from the shortlist method, in which community policing officers
periodically filled out questionnaires in a systematic way to describe the nature and extent of problematic youth groups (Ferwerda 2009). Subsequently, according to their impact on the environment these groups are classified as annoying, troublemaking or outright criminal in nature.

A number of SNA papers contrasted the results of this shortlist method with the application of SNA directly based on police registers (both patrol/incident and investigative data). Such comparisons show that the composition of the juvenile groups can be different, according to the method used (papers 24, 25 and 30). The main reason appears to be that the network boundary specification of youth groups through SNA is not related to the specific community boundaries in which the police officers filling out the questionnaires operate, but the clusters are identified using SNA measures on the available data sets. These clusters are then qualitatively assessed and labeled. Like the meso networks found in organized crime (see below), juvenile criminal groups can transcend the local domain. A number of papers point out which actors establish the connections between subnetworks, thus contributing to a better understanding of core members and followers. This SNA best practice consists of two steps.

1. The snowball method (Scott 2013): a number of persons are considered as the starting point of a network (e.g., known juvenile group members). Of these individuals, the related (criminal) contacts are identified using information from police registers. Then the same snowballing operation is performed on these newly found criminal contacts. The researcher determines how often this step is repeated. This is usually until no more new individuals are identified or when the new individuals do not meet certain predefined criteria for belonging to the network (such as multiple co-offending, involvement in specific criminal activities, or age).

2. The Core Collapse Sequence (Seidman 1983): This method can be helpful in the identification of core members. Seidman states that the structure of a network can be considered on the basis of a certain minimum degree, so that groups with a higher or less high density are distinguished (Scott & Carrington 2011). By increasing the minimum degree parameter, a cluster of core actors will be distinguished from the periphery. The result is a limited set of actors, to be considered for qualitative analysis and labeling in order to achieve the identification of core members and followers (Figure 3.2).
Combined application of these SNA techniques brings added value to existing instruments such as the shortlist method, which is currently being reviewed for enhancement with analysis of data from police registers. With the distinction between core members and hangers-on being important for the fine-tuning of interventions, SNA appears a useful first step. It should be followed by qualitative analysis to allow for definitive conclusions. Besides bringing in additional insights, SNA also promises to save time in the data collection phase, leaving more time for qualitative analysis. Whereas traditional analysis of a juvenile network requires an analyst to invest about three months of work, SNA has proven to shorten this job to two weeks.

**Analysis at the individual level**

At the actor-level, *centrality* is the most commonly used measure to determine individual positioning in networks (Table 3.4). The centrality measurements degree, betweenness and closeness respectively show which actors have most relationships, are most positioned between other actors or clusters, and are best positioned to reach anyone else in the network. Interpretation of the centrality analysis requires solid knowledge of the origin of the data, the manner in which the network is defined (boundary specification), and the workings of the underlying algorithms. Actors with a high degree are not necessarily the most influential. Von Lampe (2009) believes that central actors are often found in operational ‘workfloor-level’ roles, thereby becoming more visible, while their leaders are better capable of shielding their contacts. Morselli (2009) points out that networks that come to the attention of the police may be *failed networks*, while the smarter networks...
could succeed in remaining invisible. Interpreting the results therefore requires a more in-depth qualitative examination before conclusions can be reached. An interesting measures in this context is known are Eigenvector and Bonacich power centrality (Bonacich, 1987). Both calculate positions of network operators that are in between the central actors. Even with only a few contacts, such well-connected actors can have significant impact on the resources across the network. Papers 11 and 21 associate distinctive scores on such positions with the role of women, but influential people in the background can also get high scores on this centrality measure. For ego networks in cold cases, this measure is less relevant.

Analyzes at the individual level often lead to interesting actors as targets for interventions or to obtain strategic information positions. With these purposes in mind, Borgatti (2006) developed the keyplayer-analyses (KPP1 and KPP2). KPP1 calculates which set of persons can best be removed from the network to achieve maximum fragmentation. KPP2 identifies individuals suitable for recruitment as informants due to their optimal information position in the network. The keyplayer analysis involves a sequence of interventions executed on a network. Following each intervention, a recalculation is made for a repeated maximal fragmentation effect or information position. The exam papers in which the keyplayer analysis was applied in combination with a qualitative interpretation, yielded concrete recommendations for interventions or strengthening of the information position (papers 5, 20, 29, and others).

**Qualitative interpretation**

An essential phase in applying SNA on criminal networks is the qualitative interpretation. Between data collection and analysis, the social and criminal reality can get distorted. Analysis of the papers shows that the qualitative assessment of the information in particular proves to be the most powerful element in the SNA methodology as applied on criminal networks. Quantitative SNA helps in making relevant selections from large amounts of data. The qualitative study of these selections based on network- and criminological theory then provides insight into the mechanisms that sustain network structures, and suggests opportunities for operational interventions.

**Identifying key people: scripting and SNA**

A significant enhancement to the actor by actor relationship diagrams is the connection of quantitative results to qualitative attributes (characteristics of individual actors). As mentioned earlier, this is done by constructing an actor by attribute matrix. For qualitative enrichment on issues like organized crime, it has been found useful to combine SNA with the scripting method. Scripting is an analytical technique whereby criminal logistics are divided into separate parts of a ‘script’ in order to assign vulnerable elements (Cornish 1994; Bruinsma & Bernasco 2004; Morselli & Roy 2008; Tompson s.a.). By scoring actors
on their role in the crime script, those who appear difficult to replace are identified, which offers opportunities for interventions.

Table 3.4 shows that the scripting technique has been applied in twelve exam papers. Thus, peripheral actors with a seemingly insignificant position could be singled out, given their importance on account of their specialized roles within the particular scheme of criminal logistics. An example is paper 21, wherein scripting is applied to a synthetic drugs network (see Figure 3.3). The actors (nodes) are hereby related to the phases of the logistics process of synthetic drugs production. Figure 3.3 illustrates that only one actuator (#24) is responsible for the crucial phase 3 (production). Actor #24 can therefore be identified as a key person and a vulnerable link in the network.

Figure 3.3: the scripting technique is applied on a synthetic drugs network; the nodes represent actors; squares represent stages in the criminal logistical process of synthetic drug production (source: paper 21)

Scripting can help to identify ‘key individuals’. When choosing key Figures as subjects for intervention, the question is often whether these should be initiators of criminal operations, financiers in the background or logistical fixers who contribute essential skills, such as the ‘chefs’ in narcotics labs. Or are the brokers essential who connect different networks in the supposed ‘underworld’ and ‘upper world’?23 From the social network perspective, key Figures are the most indispensable for the continuity and growth of the crime business. They can be inspiring people, someone with social bonding or innovative skills, but also an employee who contributes the necessary technical knowledge or vital contacts.

Scripting adds the dimension of substitutability to interventions in criminal networks. Within the cannabis cultivation special attention could for instance be paid to the role...

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23 The concept of ‘criminal relationship broker’ has been introduced by Klerks (2000a) and Kleemans et.al. (2002). The relevance of this concept for criminal investigations was explored further in a confidential Police Academy thesis by Boogers (2010). This author defines a broker as ‘(…) a person (…) who manages to bridge holes in the social structure of two or more separate parts of criminal networks and assures that others in the criminal networks remain dependent on his power resources (Boogers 2010 p. 5).
of electricians in the organized cultivation of cannabis. Draining electric current from the grid in an unobtrusive manner requires a professional with specific knowledge and skills. Cannabis growers usually manage to locate an electrician prepared to do such a deviant job in their immediate social network, and even a replacement can often be found in their network should the need arise. Should both these skilled individuals become unavailable however, a replacement would have to be found outside their social circle in order to ensure the continuity of cannabis production. This would result in stress, unexpected costs and even conflicts. Things a criminal entrepreneur can hardly afford, especially if the concealment of operations is put a risk. Such electricians have often been involved in setting up dozens of plantations, implying that a single police investigation aimed at an electrician could reveal a large part of the criminal infrastructure. A long-term control strategy focused on such key Figures can thoroughly disrupt a criminal industry. Other criminal industries have similar vital functions, such as laboratory technicians, document falsifiers, money laundering consultants and underground bankers. Most exam papers on organized crime networks contained clues for the implementation of this control strategy.

### 3.4 Insights Regarding Applicability

**The practitioners’ perspective**

Crime analysts recognize the added value of SNA at the tactical and strategic levels of analysis, e.g. in (preparation for) investigations and in the periodical Inventory of Criminal Groups. For example, the authors of paper 12 state: “By applying network analysis on various subjects and criminal groups in a major regional or national database, subjects fulfilling key positions within and between the networks become visible on a larger scale”. Periodical application of SNA also emphasizes the dynamics in criminal networks.

Our survey among SNA practitioners made clear that six of the ten regional police units as well as the National Unit and the Military Police applied SNA in the areas of organized crime, criminal juvenile groups, cybercrime, child pornography, cold cases and terrorism. The direct value lies on the one hand in the “broad look” SNA offers on criminal networks: how did actors get to know each other, what is the nature of their relationships and what does it imply for their modi operandi, collaboration and interdependence? In combination with scripting, this provides meaningful insights. In addition, analysts report the use of SNA for selecting key Figures suitable for interventions during project preparation, as well as for finding new potential informants and identifying hard-core members among soccer hooligans and juvenile crime groups. SNA allows for much quicker analysis of extensive network data compared to traditional methods.
However, due to the lack of knowledge about SNA’s benefits among police chiefs and prosecutors, the potential is still insufficiently recognized. This explains why necessary conditions involving computer hardware and software remain a bottleneck seven years after SNA was first introduced. SNA processing of large data sets requires substantial computing power. The suboptimal police systems require that raw data must first be ‘scrubbed and cleaned’ before being fed into SNA software. This requires extra time, causing analysts and their managers to stick to traditional analysis methods.

**The scientists’ perspective**


Dutch criminologists have so far limited themselves to mostly theoretical discussions about organized crime from a social network perspective (Fijnaut et al 1995; Klerks 2001; Kleemans & Van de Bunt 2002; Kleemans & De Poot 2008; Spapens 2006; 2012). Spapens (2012) introduced a useful theoretical distinction between micro, meso and macro networks in international organized crime, with micro networks involving the individuals actually involved in criminal business processes in a coordinated manner, in other words all active criminal relationships. Spapens sees no added value in SNA, applied on micro networks compared to traditional criminal group analyses. He argues that apparently crucial links could prove to be easily replaceable on the (then invisible) meso level. Kleemans (2014) emphasizes validity and reliability issues hindering ‘technical’ SNA based on investigative information (mainly wiretaps) at the micro level. He advocates analysis “that looks critically at the position of individuals in criminal networks in a qualitative way, while taking such limits into consideration”.

The analyzed SNA exam papers demonstrate that the ability to draw valid conclusions about individual network positions is indeed dependent on insight in the larger networks in which such operators participate. Several students explicitly consider combining various data sources as an essential condition for valid network reconstructions, and in the exam papers quantitative SNA is usually followed by qualitative interpretation of network positions. Overall, the SNA papers and investigative science theses on SNA discussed in this article provide solid illustrations of a scientifically grounded SNA practice in the domain of criminal investigations in The Netherlands.
3.5 CONCLUSIONS AND DISCUSSION

For this article, we have studied the application of social network analysis in the investigative domain, and have described the extent in which this practice is scientifically sound. In these concluding remarks, we highlight some final interesting aspects.

Intelligence vs. investigation

Most SNA-certified analysts subscribe to the view that SNA bring an added value to their work, but they also point to certain limitations. In the detection phase of the investigative process, SNA often produces insights that investigative teams are already familiar with, which can be explained by the fact that data collection is often focused on a limited number of prime suspects. Zooming in on the immediate periphery of prime suspects can accentuate how professional criminals actually organize their criminal activities. The forensic SNA method developed for cold-case investigations also creates new opportunities for additional investigative work, with the data collection often immediately centered at the Ego network of the victim (Spreen & Vermeulen 2008; Bosveld 2010).

The main added value of SNA appears to be in the intelligence phase, where combining and merging of data partly compensates for the bias of separate data sources. In intelligence work, data collection can be targeted at specific criminal networks at the meso and macro levels through informants, with a focus on specific SNA aspects. Linking large amounts of data necessitates the use of quantitative SNA for the argued designation of actors that, given their network position, require more in-depth qualitative scrutiny. The application of SNA has no direct consequences for the suspects in this initial phase of primary selection, before the eventual investigation and possible interventions are initiated. SNA only contributes to the forming of hypotheses for strategic and tactical decision-making, after which the criminal detection process might produce evidence.

SNA practice and academia

In the context of criminal investigations in The Netherlands, SNA is predominantly carried out by ‘embedded academics’: often trained criminologists, lawyers, administrative, political and social scientists who subsequently received additional training in investigative science or security analysis at the Police Academy. Their analyses and conclusions can stand the test of scientific criticism provided that their methodology is sound and applied in a responsible manner. They are taught a set scientifically developed and tested SNA methods and techniques, presented in a context of social science insights grounded in the academic literature. The SWISNA exam requires a solid scientific foundation as a condition for students to succeed.
Such scientifically based and empirically robust network analyses present an exciting challenge to the established scientific community. Data-driven analysis of juvenile criminal groups for example produces different results compared to the hitherto prevailing shortlist method developed by Beke (Ferwerda 2009). This standard method, now under revision, has mainly confirmed the concept of divergent groups by relying primarily on interviews with locally-oriented police officials, thus ‘scientifically validating’ the prevailing concept of separate offender groups. In studying organized crime, SNA ties in well with current scientific knowledge, but also requires rethinking the prevailing concept of rather rigid criminal organizations, which is still the premise underlying many criminal investigations targeting organized crime (Huisman et al 2011). All this requires a dialogue and perhaps an enhanced cooperation between academia and police practice. Police embedded academics, often positioned at the edge between different communities of practice, are ideally positioned to exploit the high betweenness, credibility and trust that allows them to initiate collaboration and stimulate the sharing of expertise and resources. Sharing anonymized datasets and exchanging insights at the network level becomes particularly interesting when criminologists start to look into advanced SNA applications and are prepared to share their knowledge with police analysts.

**Future prospects**

SNA offers additional value when compared to traditional analytical techniques, primarily because social and criminal relationships are calculated mathematically. This answers questions about the strength of networks and variations in concentration therein, their dynamic development and interactions, the role of key Figures, et cetera. In addition, SNA embedded in multidisciplinary social science relates socio-psychological and criminological knowledge to network patterns, thus providing a conceptual framework for understanding the embeddedness of criminal activities in social relationships. This approach values aspects such as trust and loyalty, power and secrecy, rituals in secluded communities and economic interests. Departing from these insights, we learn how unlawful behavior can best be countered. This area of expertise is now developing into a data-driven ‘intervention criminology’ by combining SNA with the scripting of criminal business processes. It supports an awareness of which agencies in the integrated fight against crime at what point can best seek cooperation by sharing information pooling resources and combining specific interventions. Building on the police strategy of ‘nodal orientation’, SNA and the scripting technique are combined with analysis of the physical criminal infrastructure to attain a ‘laminate model’ of overlapping criminal dimensions, in which critical nodes of organized crime are linked to interventions (Klerks & Kop 2004; Klerks 2008).

SNA is also applicable to cyber and financial-economic crime, where oceans of data await analysis (Visser 2013). Analysts currently try out SNA to unravel networks behind scam-
mers, hackers and producers of child pornography. Van Eck (2013) combined investigative
information with intelligence on human smuggling networks from the Middle East, thus
exposing irregular migration chains within a transnational network of transporters, safe
houses and document providers.

The so-called ‘big data’ revolution characterizing the present era opens new windows of
opportunity to multidisciplinary research (Mayer-Schonberger & Cukier 2013). The term
‘big data’ refers to the ever-increasing diversity, quantity and of accelerated availability of
data available to us. Big data on criminal networks has the potential of revealing answers
about its dynamics and meso/macro structures, which can be difficultly analyzed by the
traditional manual methods of qualitative research. SNA becomes increasingly important
to make sensible selections in these large amounts of data and also opens the door to
a computational approach. Recent studies utilizing computer simulations in combination
with SNA for instance (e.g. Bright et al 2014) help us understand the dynamics of the
complexity behind criminal networks as a result of law enforcement interventions. Such
studies offer the perspective of computational criminology as new criminological discipline.
However, this will never lead to computers deciding which interventions are to be carried
out, provided that the quantitative approach is restricted to providing the means to allow
for theory-driven qualitative interpretation. A multidisciplinary approach is indispensable
because numerical output in itself says little about the ways to approach and control a
criminal network. In forming and testing hypotheses about types of relationships, roles and
positions, the bridge between investigative practice and academia can best be expressed.

A final word of caution seems appropriate. Social network analysis is fairly complex, and
a responsible use will profit from thorough quality control through a peer review process.
An active and well-informed intelligence community, well-connected with the academic
domain, forms the best guarantee for mutual help, inspiration and the dissemination of
innovative knowledge.

This chapter provided an empirical overview of the feasibility and potential of
SNA as a method for detecting and disrupting criminal networks. Although it
has much potential, an important limitation of SNA is that it mainly provides a
static observation of a dynamical phenomenon. Subsequently the application of
SNA has mostly been limited to criminal networks observed on a micro-level. For
more deliberate targeting of criminal networks we need a better understanding
of its macroscopic patterns of resilience and the dynamics that fuels its typical
complex adaptation over time. In the next chapter we use SNA in combination
with modeling macroscopic network behavior through computer simulation to
obtain a better understanding of these dynamics and its consequences for effective disruption strategies.

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The papers produced during the SWISNA training at the Police Academy are, without exception, classified as (highly) confidential. Usually, the analyses and reports are based on individualized data drawn from operational police registers and involve active investigations that fall within the legal regime of the Law on Police Data. Furthermore, the reports provide insights into current information positions, resources, and (experimental) detection methods. Finally, the papers are written by students of the Police Academy in the context of their training, and as such are not subject to the usual procedures of quality control and supervision by police management and the Public Prosecutor.
### SWISNA exam paper titles

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<td>34 Production of synthetic drugs</td>
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