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A virtuous combination of structural and skill analysis to defeat organized crime

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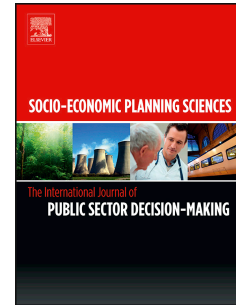
A virtuous combination of structural and skill analysis to defeat organized crime

1. Introduction and summary

Criminal networks arise and develop, to pursue illegal aims, disguising the shady activities performed and maximizing the profits. The members of such networks trust one another and look for protection or for a privileged access to certain social as well as economic resources (Skaperdas, 2001; Sciarrone, 2009), often through the mediation of individuals who offer their services in a "non-transparent" or irregular way (Barucci, 2008). Therefore, we cannot consider them as simple networks of interpersonal relationships among individuals operating "in the shadow", or anyway in a criminal contest (Ozgul and Erdem, 2015)[1]. In fact, criminal networks have peculiar characteristics which cannot be underestimated or ignored in trying to develop effective preventive and contrastive measures and policies. Several studies highlighted how criminal and terrorist organizations carry out their activities in dynamic contexts, in which the competitive pressure and repressive intervention by the governments constantly test their existence[2]. This is the reason why, in order to survive and keep on growing up, they had to develop a high resistance ability[3] as well as a high adaptability to the changing conditions of the environment they operate in. The new waves of Islamic terrorism worrying the whole Western world, the proliferation of criminal organizations trafficking organs and human beings, as well as the expansion and reproduction abilities of the traditional Mafia factions (clans) dramatically show how organized crime is able to progressively improve communication tools   and/or recruitment methods to reproduce itself and grow up in the globalization era.

All this is strictly related to peculiar resistance abilities and a particular adaptability, which is generally referred to the term and, at the same time, the concept of "resilience", "borrowed" from other sciences and implying the elasticity and adaptability of bodies, passions, systems and even territories (Schoon, 2006). The nature and source of such abilities, as far as criminal and terrorist organizations have been deeply analysed in several researches[4]. In fact, such organizations, due to their topological characteristics, are considered as an extreme and very interesting case of *failure resilient networks*, i.e. networks which are resilient towards the so-called "cascade failures"[5], and therefore they will also be analysed in this paper, with particular reference to the structure and resilience ability of two criminal networks, the first one set up for international drug and psychotropic substance trafficking and the second one operating in the field of public services in some Social and Healthcare Territorial Institutions.

The analysis is carried out using an interdisciplinary approach as well as the typical techniques and concepts of the *Social Network Analysis* (SNA) in order to develop a reliable indicator of *Criminal Network Resilience* (CNR). The techniques offered by the analysis of social networks have rapidly widespread in the last years, even in the study of criminal networks, and their results convinced the institutions and law enforcement agencies to use them more and more frequently. In fact, the concept of social network was applied to the study of crime and to the several forms in which it operates and

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[1] Scholars are still debating on this issue. They are trying to determine if criminal networks may be assimilated to other type of social networks (Pedahzur and Perliger, 2006; Eberle, 2012) and if, in particular, the several organized crime forms set up to commit crimes and to obtain, directly or indirectly, financial or material benefits, have the same topological and solidity characteristics of the other real networks, such as the Internet, biological networks or the networks of bibliographical quotes and scientific cooperation (Albert et al., 2000; Watts et al., 1998). However, the most recent empirical studies show that, due to their typical characteristics (secrecy, decentralization), this kind of organizations cannot be in any way assimilated to other social networks (Lindelauf *et al.* (2009), Natarajan (2006) and Ozgul and Erdem (2015)).

[2] See, among other things, Skaperdas (2001), pp. 184 and ff., and Ayling (2009), p. 182.

[3] See Agreste at al. (2016).

[4] The differences between terrorist networks and other criminal networks have been well illustrated in a recent study by Ozgul (2016). He also classifies terrorist network topologies into six topology types and examines the different way in which the key player problem arises in this particular type of social networks.

[5] See above all Gutfraind, who carried out some researches (Gutfraind, 2010 and 2011) on different kinds of criminal networks in order to identify a topology which, for itself, could guarantee a good resistance level towards cascade failures. See also Callahan, Shakarian *et al.* (2012) and McGuire (2014).

organizes, but above all to the analysis of transnational crime and terrorist networks (Sparrow, 1991; Waring, 1993; Klerks, 2001; Morselli, 2009; Krebs, 2001; Calderoni, 2014; Strang, 2014; Ozgul, 2016).

The network approach widespread in a contagious way among researchers, the law enforcement agencies and the authorities charged with the application of law in each country because it is considered as a more efficient and effective tool to combat organized crime than the traditional investigative methods (like wiretapping: see Agreste *et al.*, 2016) and the traditional *criminal intelligence* techniques (Castiello, 2015). In fact, there is the conviction that it is an inestimable instrument able to put together and to interpret different information and several observations by detecting an understandable model of behaviour and social action able to show the logic, or the "rules of the game", ruling the relationships among individuals (Ianni A. and Ianni R.E., 1990). Moreover, the use of this technique to the study of criminal organizations could be very useful to understand how they exchange information, weave relationships and partnerships with affiliates and other types of partner in crime, taking "new productive forces", organize their relationships interpersonal and alliances with members of the so-called "gray area" in which lurk the relationships of complicity and collusion of the professional, economic, political and cultural worlds with the criminal world. The application of the SNA may be helpful even in the legal field[6], in order to better define the areas of contiguity to the mafia groups (in particular, in all cases of external collaboration and support of criminal organizations[7], including those of complicity in the mafia-related criminal conspiracy, typical of the common law systems[8]) and to develop more effective legal instruments of prevention and repression of organized crime.

This paper is structured as follows: in the second section we will try to identify the key concepts and some methodological criteria to define a reliable indicator of *criminal networks resilience* (or, more in general, of *dark network resilience*[9]) in an appropriate way; in the third section it will analyses the structure and the characteristics of the concerned *networks*, highlighting how the combined use of the analysis techniques of complex networks and of the economy of human capital as well may bring to the development of more effective and efficient policies able to contrast organized crime; finally, in the fourth section it will try to draw some conclusions and to propose some *policies* to combat the organized crime.

2. Criminal networks resilience: key concepts and methodological criteria

Before developing a reliable indicator of *Criminal Network Resilience* (CNR), it is necessary to define some key concepts identifying the fundamental characteristics of a criminal network and differentiating it from the other social networks.

First of all, a criminal network is characterized by the secrecy and covering (or protection) level it is able to guarantee to its members[10]. Usually, such a characteristic does not belong to other social organizations and implies the existence of firm trust relationships among the members. In fact, studies on social capital show that trust is often a necessary condition, even if not sufficient, to set up a cooperation for any kind of purposes. However, the huge literature on the Mafia phenomenon highlights how criminal organizations are "interested in maintaining a low and impersonal level of general trust, as in this way the demand in the personalised trust they are able to offer and guarantee increases" (Sciarrone, 2009).

Another fundamental characteristic of such organizations is their *networking* ability, i.e. their ability to build relationships, to make alliances, to establish exchanges, as well as to promote mutual obligations and favours. Not only they are interested in integrating in their network a certain individual, but also in

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[6] Partially, the potential benefits arising from the application of SNA to the legal field have already been highlighted by Agreste et al. (2016).

[7] For an in-depth analysis of common trends and differences in the ways in which, in civil law countries, jurisprudence and doctrine deal with the phenomenon of the proximity to criminal organizations, see Visconti (2010).

[8] For a detailed description of the differences between conspiracy and complicity, see Brody, Acker and Logan (2001), McSorley (2003) and Sergi (2015).

[9] Including in this denomination all types of network which operate covertly and illegally, such as insurgent networks, terrorist groups or narcotics-trafficking networks. For a more in-depth analysis of these networks and a preliminary theory of *dark network resilience*, see Bakker *et al.* (2011).

[10] See, in this regard, Fielding (2017) and Lindelauf *et al.* (2009).

accessing to and maybe activating the *network* the individual already belongs to. This allows the several members of those networks to act, according to the circumstances, as mediators, patrons, protectors, in relationship structures of different forms and nature they are able to exploit in order to reach their illegal aims.

The SNA shows that a high clustering coefficient and a low average path length among the nodes of a network (typical features of many social networks, neural networks, computer networks and, in general, of all the small world networks[11]) promote the communication and relationships of the individuals in the network, thus making this latter more "effective". However, these characteristics of the network can threaten its security, as a wider sharing of the information inside it may substantially help the *intelligence* activity carried out by the enforcement agencies, reducing the secrecy and covering level of the network itself. This is the reason why we think (see Enders and Su, 2007; Lindelauf *et al.*, 2009 and 2011) that criminal organizations have to address a clear *trade-off* between effectiveness and security of the *network*, between the aims concerning security and those concerning the uncontrolled flow of information every day. Therefore, the fundamental dilemma of each criminal organization is balancing its need for strategic initiatives resulting from a wide access to certain resources (goods, services, information), gained by using weak links, with the need for consolidated and trusted collaborations, promoting secrecy, protection as well as repression of those behaviours which do not comply with the aims of the organization and implemented through the application of rules and sanctions (Ozgul and Erdem, 2015).

Another characteristic which is essential in determining (or in increasing) the resilience of a criminal *network* is represented, as already underlined (see § 3.1), by its topology (Xu and Chen, 2008; Ayling 2009). A "mixed-star" structure guarantees, without any doubt, a particular resistance to *random* attacks while the redundancy in connections and a minimum low average distance guarantee the continuity of the illegal activities on the one side, in case one or more nodes are removed, and a better communication system on the other side (*time to task*). On the contrary, a decentralized and widespread structure allows a higher confidentiality in communication. Nonetheless, a highly decentralized network makes it more difficult to manage the trafficking activities (for instance drugs and money) and to move resources[12].

Some criminal networks may have important dimensions and act at international level. In order to detect their structure and measure their organizational dimension, we use the centrality and centralization indexes. While the first ones identify the position of each nodes in the network, the second ones measure the level of hierarchization of the first one as the whole. Low and high values in the centralization level indicate, respectively, a low and high level of hierarchization. If centralization is based on the control of the information flows (*rush* or *betweenness*), it indicates, in case of high values, that some members of the *network* are in a position of *brokerage* and that the network, in order to function, needs intermediaries connecting its various subgroups.

Finally, another distinctive characteristic of some criminal brotherhoods is the robustness. In SNA this term usually indicates the ability of a network to maintain its own connectivity characteristics even after a fraction *f* of its nodes has been removed. Of course, such a characteristic has some immediate practical effects and concerns those processes which can be carried out through a network. Therefore, it is not by chance that this was one of the first characteristics of *networks* to be analysed in literature, especially with reference to complex networks, such as the Internet, the transportation or energy networks. However, such characteristic also distinguishes some kinds of criminal networks, such as the Mafia organizations, in which the redundancy in connections, typical of the family *clusters*, allows to immediately substitute any arrested or killed members.

According to these observations, part of the literature (Ozgul and Erdem, 2015) tried to propose a very simple way to define a reliable CNR indicator envisaging that the resilience of a criminal network results from the following elements:

1) the level of secrecy or coverage of the criminal network, which can be defined through the analysis of transitive triple calculating, the so-called Clustering Coefficient (CC);
2) the level of spreading of the knowledge and information inside the network, measured by the average geodesic distance (*Average Path Length*, APL) separating all pairs of its nodes;

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[11] See Watts and Strogatz (1998), Wang and Chen (2003), Telesford *et al.* (2011) and Castiello (2015).

[12] In-depth studies carried out on this topic (Everton, 2006; Locke, 1995) show different *performance* levels related to the kind of structure. *Networks* with too much centralized or decentralized structures tend to have lower *performance* levels in comparison with networks with an intermediate centralization degree.

3) the *leaders* average centrality (*Average Centrality of Leaders*, ACL), which in a criminal network shows how much authority is actually in the hands of those who act like leaders;

4) the total number of the members of the network, which gives an approximate measure of the robustness of the *network* (*Robustness*, R).

In this way we can identify a first simple algorithm able to estimate the resilience of a criminal network, or its resistance ability and adaptability to the changing conditions of the environment in which it operates:

$$[1]\ \phi = \log\left(\frac{ACL \cdot CC \cdot R}{APL}\right)$$

However, as already highlighted (see § 3.1), the previously listed characteristics are not the only elements able to affect the level of resilience of a given criminal *network*. In order to define an effective direct attack strategy able to disjoint criminal networks, it is also necessary to take into account the great amount of the available social and human capital. The Ozgul and Erdem algorithm showed at [1] represents a valid instrument to measure the CNR as well as a valid basis to develop new and more effective policies to contrast organized crime. However, it does not take into account that the resilience of criminal networks often depends on personal training and qualities, as well as on the essential skills of their members. In these cases, in fact, if an individual with specialist knowledge and skills is removed (e.g., arrested or killed), the network may be unable to replace them with an individual of commensurate quality, leading to suboptimal functional capacity of the network[13].

Therefore, the above-mentioned indicator should be integrated as follows:

$$[2]\ \phi = \log\left(\frac{ACL \cdot CC \cdot R \cdot AHC}{APL}\right)$$

where AHC is the Average Human Capital, that is the value of the skills and competences which ensures the normal functioning of the network and the achievement of objectives pursued by the criminal organization. This element gives an approximate measure of the human capital available by the members in the network to carry out the unlawful activities and reach the common illegal aims. This index can theoretically range from $+1$ to $+\infty$[14]. Its value should reflect the appropriateness of personal skills of the individual players in the network – as evidenced by the assessment made by investigators or prosecutors in judicial documents – to the aims and the activities carried out by the criminal organization.[15].

3. Analysis of the resilience of the observed criminal networks

The analysis of resilience of the observed criminal networks is based on several type of judicial documents (depositions, interrogations, warrants of arrest and verdicts) issued by the judicial authority during recent police operations aimed at dismantling two dangerous criminal networks engaged in

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[13] For further information about the factors that strengthen or weaken the resilience of dark networks, see Bakker *et al.* (2010).

[14] 1 is the minimum value of AHC that includes all non-specialist skills which in any case contribute to the functioning of the criminal organization. Obviously, the AHC changes with R, that is, with the number of members of the criminal organization that can be theoretically infinite.

[15] In this paper we do not address the problem of measuring the special skills owned by the members of criminal network, but it is obvious that the question of the motivation of choosing a specific measure of them should be the subject of a future analysis. It is known, in fact, that human capital measurement methods are the most diverse, not only because of the diversity of theoretical settings, but also for the multitude of statistical methodologies and information on which measurements are based. Any use of an indicator which is not an efficient or appropriate measure for the cognitive purposes of the survey may be misleading for the scholar of these social phenomena. We must consider, too, that there are no databases collecting information on the level of skills possessed by members of criminal networks. To date, for sociological and economic literature this interesting area of investigation is still completely unexplored.

international illicit drugs trafficking[16] and in supplying health and social services at a local level. In particular, the first operation was named "Freccia Sarda"[17] (*Sardinian Arrow*) and allowed to identify a group of Nigerian and Italian criminals engaged in international drug trafficking among Sardinia, Campania, South America and Holland. The second operation was named "Il principe e la scheda ballerina"[18] (*The prince and the dancing card*) and allowed to arrest several members and flankers of a *clan* belonging to the Casalesi family, a famous Camorra cartel, composed of 10 clans, operating in the sector of social and healthcare services in some Municipalities and Territorial Districts of the province of Caserta[19]. The analysis of two criminal networks aimed at carrying out different offenses is very useful because it serves to highlight how individuals with different skills and competences exist in almost all types of criminal organizations. Generally, such individuals are members of these organizations or collaborate externally with them albeit they formally do not form part of criminal networks. This involves the need to in-depth study these cases to create public policies and legal instruments appropriate to discourage any form of collaboration between the abovementioned individuals and criminal organizations, as well as to fight all kinds of mafia contiguity currently pursued with toothless weapons (that is with ineffective and inefficient tools)[20].

4.1. "Freccia Sarda" Operation

4.1.1. Topological analysis of the observed criminal network

The observed criminal network is made up of three different criminal organizations tracing back to some Italian and non-EU citizens (coming from Nigeria, Kenya and Ghana). The network has, as shown later, a cellular structure, which is typical of several complex networks. The organization had two operating bases, one in Castel Volturno, in the province of Caserta; the other in Cagliari, Sardinia. Drug trafficking, above all heroin and cocaine, involved Italy, South America, the United Kingdom and Holland.

The network was made up of 70 actors and 125 connections. The connections among the members of the network came from information or resource exchanges (drug, money) and this is the reason why we chose to analyse this kind of relationships by symmetrizing its connections.

The level of cohesion measured thought the "density" of the network shows a very low value (0,052) that means almost 5% of all possible connections is present. This value highlights a very low level of cohesion of the group. The average degree level is 3,50 degree for each node, i.e. each individual activated, on average, almost 3,5 edges, a value confirming the reduced level of cohesion of the group. As there are not many direct connections among the several members of the network, we can assume that the communications or the exchanges of resources and information were guaranteed by indirect connections, i.e. by individuals acting as intermediaries.

The structure of the *network* shows a distribution of degree which follows a power law, a high clustering coefficient and a low minimum average distance among all pairs of nodes inside the network ("small world" effect). The Alpha value of the level distribution (2,48), the p-value (0,81) and the value of the *goodness of fit* (GOF = 0,051) confirm the characteristics of a scale-free network. The 62% of the connections is distributed on 4 main *hubs* which can be referred to four actors N19, N18, N63 and N47,

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controlling the whole drug trafficking process, from the import of the substances produced in South America to the distribution in Sardinia. The highest values of *degree* and *betweenness* are mainly distributed on three actors (N63, N18 and N19) and less on actor N47 (see Fig.1).
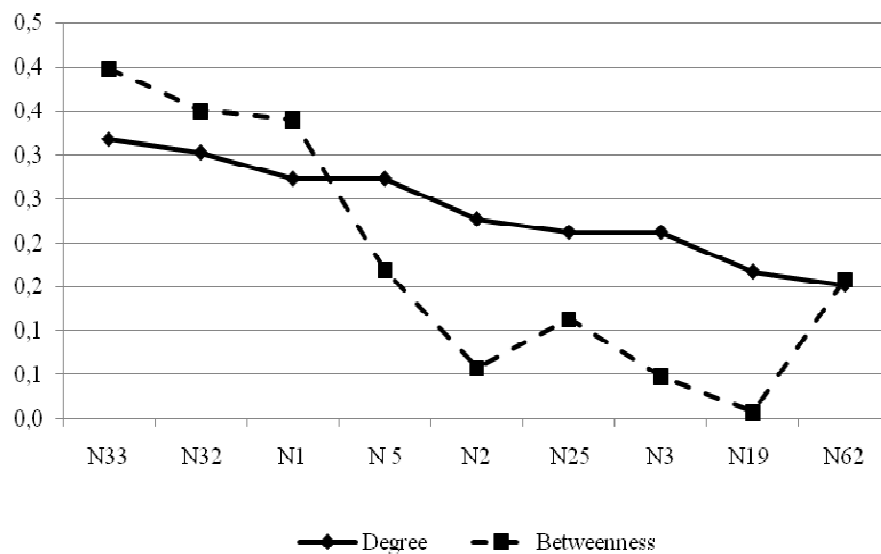
Fig. 1 – "Freccia Sarda" Operation. Distribution of the degree and betweenness centrality
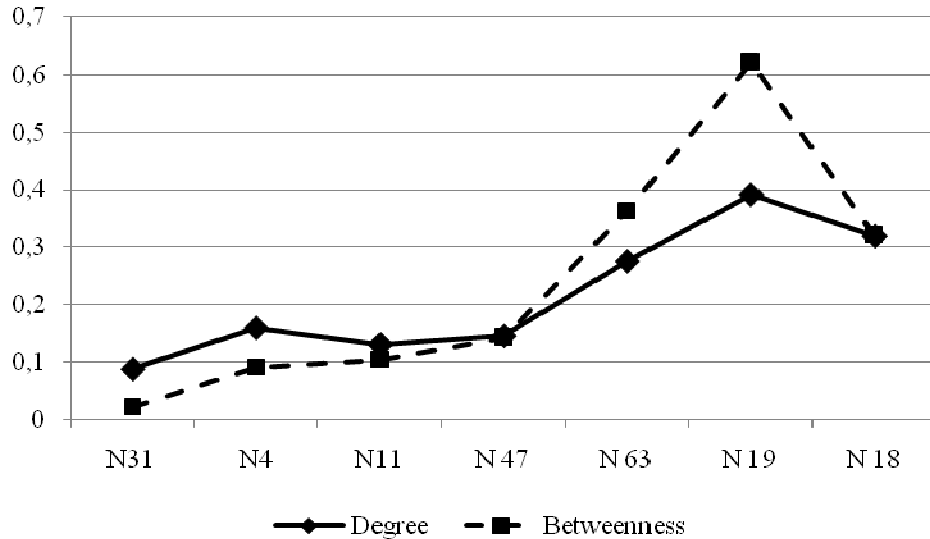
Source: Our processing of the data supplied by the D.D.A. (Local Anti-Mafia Investigation Department) of Cagliari.

Moreover, the analysed network shows a quite hierarchized structure, the *degree centralization index* is 35,93%, while the *betweenness* has a value of 60,93% and this supports the idea that most of the relationship activity of the *network* is carried out by mediators or *brokers*. In fact, the analysis of the "brokerage" (see Fig. 2) highlights how most of the intermediation activity refers to nodes N18, N19 and N63, which actually connect one another the several parts of the network. They have a structural position of *gatekeepers*, i.e. they can act like "guardians", as they control the information and resources of people outside the group they belong.

Fig. 2 – "Freccia Sarda" Operation. Analysis of the brokerage activity

Source: Our processing of the data supplied by the D.D.A. (Local Anti-Mafia Investigation Department) of Cagliari.

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The average path length among the nodes of the network is 2,932, while the average clustering coefficient   is 0,673. If we compare these two values with those resulting from a *random* network of the same size and average degree, it results in the following:

- as far as the clustering coefficient is concerned, a great difference, i.e. 0,673 for the real network and 0,054 for the random network;
- as far as average path length is concerned, a more moderate difference, i.e. 2,932 for the observed network and 3,374 for the *random* network.

Such values confirm the "small world" characteristic of the criminal organization taken into account. The reduced average path length among the nodes and the high level of local cohesion guarantee the network a high level of effectiveness, which is functional to the success of the activities related to drug import and distribution.

As far as the nature of the connections among the actors of the main *hubs* of the network is concerned, the prevalence of family or emotional connections was highlighted (strong ties)**,** strengthened by an ethnic bond (the organization is mainly made up of non-EU people, with the participation of some Italian individuals), while in minor roles (ovule-eating carriers, small pushers) the prevalence of weak connections (weak ties) simply based on acquaintances or role similarities was highlighted (Granovetter, 1973).

The relationship dynamics show a tendency of the minor actors (carriers and medium-level pushers) to connect with those showing a high *degree* (preferential attachment), as they have particular abilities or *fitness* (Mosca and Villani, 2012; Barabàsi, 2002) in managing drug trafficking, because they are able to develop and maintain contacts with higher level suppliers (international traffickers) and the ability to earn money from the drug sale.

4.1.2. Analysis of the resilience level of the observed criminal network

We can assume that the observed network shows the typical characteristics of scale-free networks and the "small world" as well. Such characteristics give it, as noticed, a high level of effectiveness in managing illegal trafficking and, in general, a good level of robustness towards *random* attacks. Nonetheless, we wished to check the robustness of the observed *network* and its characteristics by simulating two kinds of attack.

The first kind of network attack ("random attack 1") aimed at randomly removing all nodes with a low level of degree, between 1 and 3, i.e. ovule-eating couriers or low-level pushers; the second attack ("random attack 2"), the one which was actually carried out by the police thanks to the information acquired by the investigating bodies, aimed at neutralizing all couriers and pushers recruited by clan leaders or by those acting like mediators for drug transportation (specifically affecting actors, in this case, are N34, N9, N1, N24, N45 and N31)[21].

The results of the two attacks are listed in Table 1 and showed in Figure 3 here below.

Table 1 – "Freccia Sarda" Operation. Analysis of the network topology and of the effects of simulated random attacks
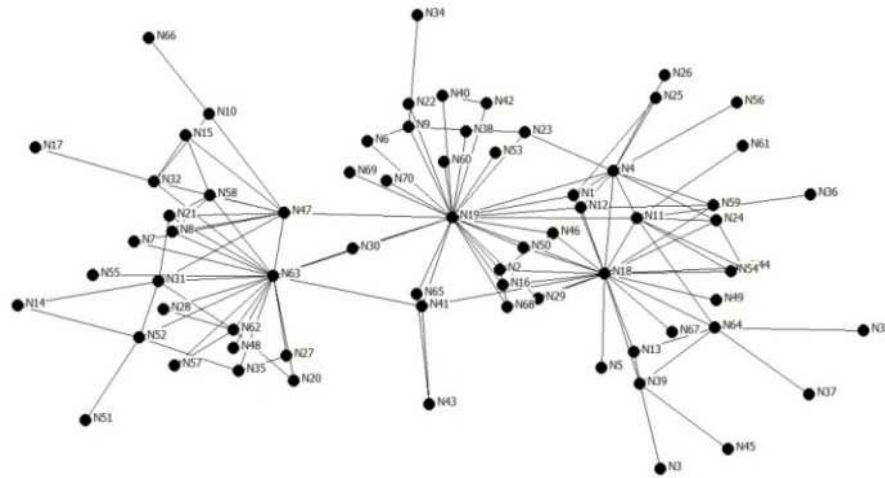
	Original network	*Random* attack 1	*Random* attack 2
Size	70	34	63
Alpha	2,48	2,75	2,31
P-value	0,81	0,71	0,84
GOF	0,051	0,058	0,04
Clustering coefficient	0,67	0,72	0,61
Avarage path lenght	2,93	2,75	2,93

Source: Our processing of the data supplied by the D.D.A. (Local Anti-Mafia Investigation Department) of Cagliari.

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[21] We considered this second attack random, because the police forces ignored the whole network and they arrested, by a parallel operations, only drug dealers less connected (drug couriers). On the contrary, for an assessment of the effectiveness of sequential police attacks, see Agreste *et al.* (2016).

Fig. 3 - "Freccia Sarda" Operation. Representation of the original network and of the simulated random attacks

3.A. Original network.

3.B. Network after random attack 1.
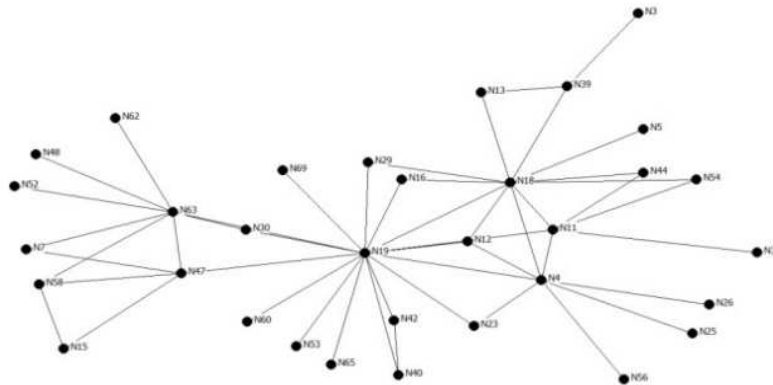
3.C. Network after random attack 2.
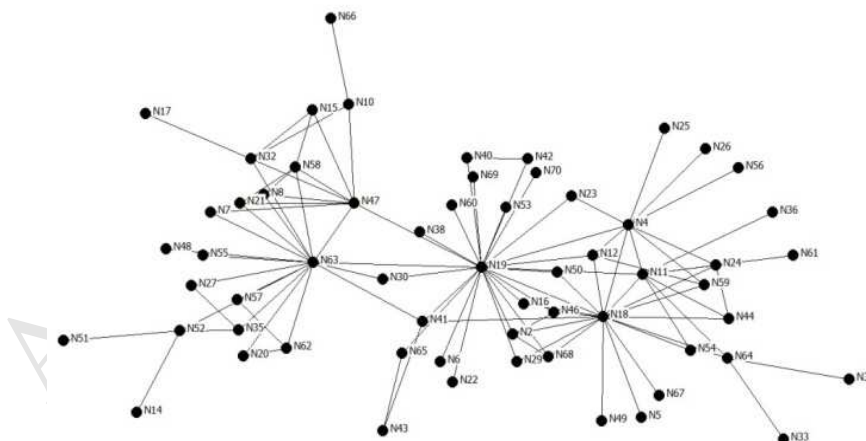
Source: Our processing of the data supplied by the D.D.A. (Local Anti-Mafia Investigation Department) of Cagliari.

It is easy to notice that, despite some actors of the network were removed, its structure remains intact (see Table 1). In fact, it maintains the same characteristics of the original graph (Fig. 3.A.), both by just removing 7 nodes (Fig. 3.B.) and by removing 36 nodes (Fig. 3.C.), i.e. more than the half of the members of the network.

As far as the topological characteristics are concerned, the observed network is resilient to the *random* attacks towards the nodes with a low *degree*. On the contrary, if the contrasting (repressive) activity

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concerns the *hubs* characterized by a high value of *betweenness*, the results are diametrically opposed: by removing N18, N19 and N63, which represent the heads of the criminal organization, the network breaks up in 21 components, of which two are made up of 24 and 18 nodes respectively (Fig. 4.B). This brings to the loss of leading figures in the organization and to serious damages to the drug trafficking process.

Therefore, the obtained results show, how it was possible to notice, that the attacks carried out following the social capital approach bring to an important breaking up of the *network*, even if it is necessary to underline that the observed network is still alive and operating, thanks to the preservation of some members with particular skills and able to guarantee its survival and "regular functioning"[22]: N58, close to N47 and N63, called "'o professore" (the professor), who dealt with the recruitment and legal assistance for the arrested carriers; N62, brother of N63, who was substituted by the first one, after his arrest, in the management of illegal trafficking, thanks to the skills of N30; N11, wife of N19, who revealed a woman able to manage drug trafficking on behalf of her husband; N41, partner of N18, who maintained the contacts with carriers and customers; N47, head of that part of the organization located abroad, who, thanks to two inside men living in the Netherlands and in the United Kingdom, N8 and N21, dealt with the import and distribution of drugs from South America to Italy.

If we really wish to weaken the *network*, we need to implement a different strategy aiming at affecting those individuals who have the above-mentioned particular skills. In other words, we need to adopt a contrasting (repressive) strategy based not only on social capital, but also on the available human capital inside the *network*. Later in this paragraph we try to estimate the effectiveness of a similar strategy by simulating an attack aimed at removing all nodes which cannot be easily substituted, as they have special skills and are connected with the *hubs* of the network by strong connections.

Table 2 and Figure 4 show the obtained results. The attack carried out following the human capital strategy breaks the *network* up in two components: the first one made up of 2 nodes; the second one made up of 60 nodes and 88 edges (connections). However, even if the network preserves its characteristics of scale-free and "small world", the latter seems to be in this case much less resilient, because it lost the highly professional skilled elements able to guarantee the regular functioning of the *network* even when it was under attack.

Table 2 – "Freccia Sarda" Operation. Social capital and human capital strategies

	Original network	*Random* attack	Human capital attack
Arrested or killed criminals	0	7	9
Size	70	63	61
Alpha	2,48	2,31	2,52
P-value	0,81	0,84	0,33
GOF	0,05	0,05	0,79
Clustering coefficient	0,67	0,61	0,67
Average Centrality leader	0,33	0,28	0,27
Average Path Lenght	2,93	2,94	2,98
Average Human Capital*	1,71	1,71	1,00
Ozgul-Edmer algorithm	1,67	1,31	1,30
Our algorithm	2,20	1,85	1,30

Notes: * The minimum value of the *Average Human Capital* is 1 (no individual with special skills).
Source: Our processing of the data supplied by the D.D.A. (Local Anti-Mafia Investigation Department) of Cagliari.

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[22] Recent research related to the illicit drug market in Australia has shown that some of the individuals in the methamphetamine networks possess highly specialized knowledge and/or skills (e.g., chemistry knowledge, knowledge of law enforcement tactical measures). The most obvious examples of this are the corrupt officials and the cook/cook instructors. These roles and specializations are of critical importance for methamphetamine networks functioning. In fact, the presence of role differentiation and replication implies that, with the exception of the leaders and brokers, the removal of a network participant is unlikely to lead to network collapse. See again Bakker *et al.* (2010).

The use of the resilience indexes we have previously described (see § 3.2) clearly confirms the greater effectiveness which distinguishes the attacks carried out following the human capital strategy than the *random* attacks based on the social capital approach (see Table 2). In fact, if we compare the resilience level of the *network* before and after the attacks, we can see how these latter significantly broke the criminal network. After the attack it appears much more weakened. But while *random* attacks only brought to a net reduction in the average centrality level of *leaders* (from 0,33 to 0,28), significantly reduce the power they can exert inside the *network*, the attacks based on human capital caused a significant reduction in the spreading of the knowledge and information inside the network. In fact, in this last case the average geodesic distance has significantly increased (from 2,93 to 2,98). Ozgul's and Edmer's algorithm does not clearly detect this difference. In fact, it has only slightly decreased – precisely by 0,8% – in the case of the attacks based on the human capital strategy. On the contrary, the resilience index proposed by this research is much more sensitive and able to measure the effects caused by such attacks. In the concerned case it has significantly decreased: by 16%, as far as *random* attacks are concerned, to 30%, as far as human capital attacks are concerned.

The graph shown in Fig. 4.C. allows us to make an important observation. Even after the attack based on human capital, the criminal network remains intact and functioning. Even if it loses 10 nodes, it keeps on enjoying a high level of robustness (as highlighted by the values *Alpha*, *Goodness of fit* and p-value) and effectiveness (measured by the *Clustering Coefficient* and by the *Average Path Lenght*). Actually, removing or seizing those individuals having particular professional skills and competences that it is difficult to substitute, at least in a short term, paralyses the organization activities. Identifying such a paradox is essential and suggests the adoption of new and more effective repression policies, able to combine the benefits brought by the adoption of attack strategies based on social capital with the benefits resulting from the application of strategies based on human capital.

Fig. 4 - "Freccia Sarda" Operation. Representation of the original network and of the effects caused by the simulated attacks

4.A. Original network.
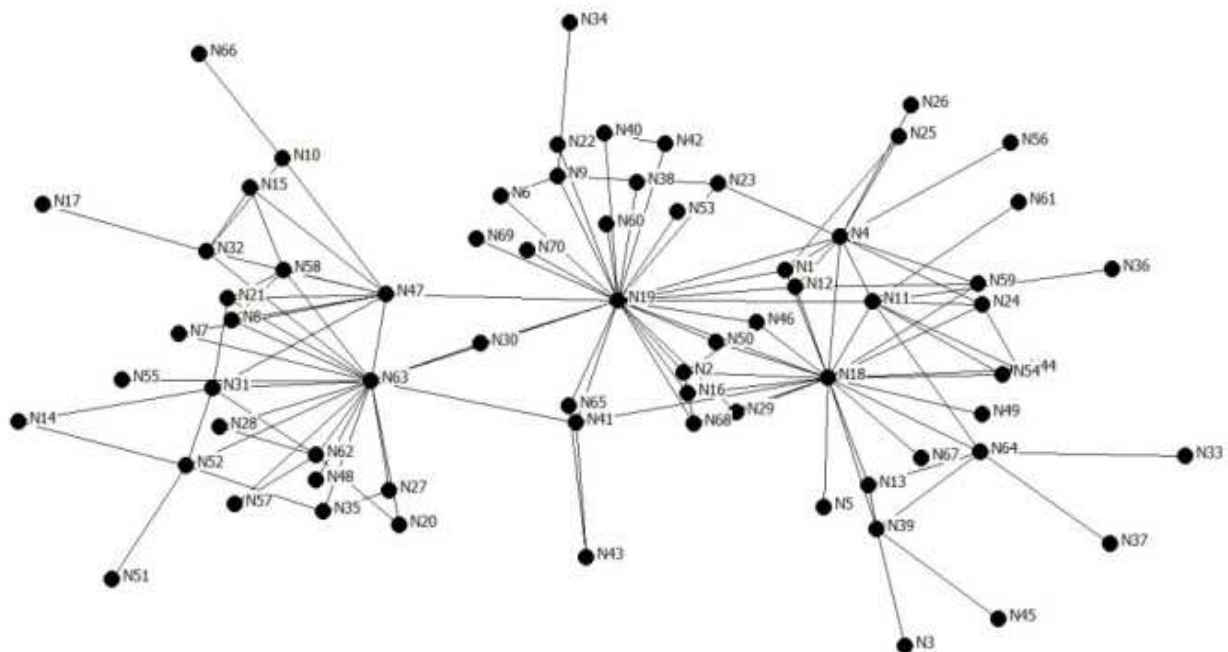
4.B. Network after selected attack based on the social capital approach.
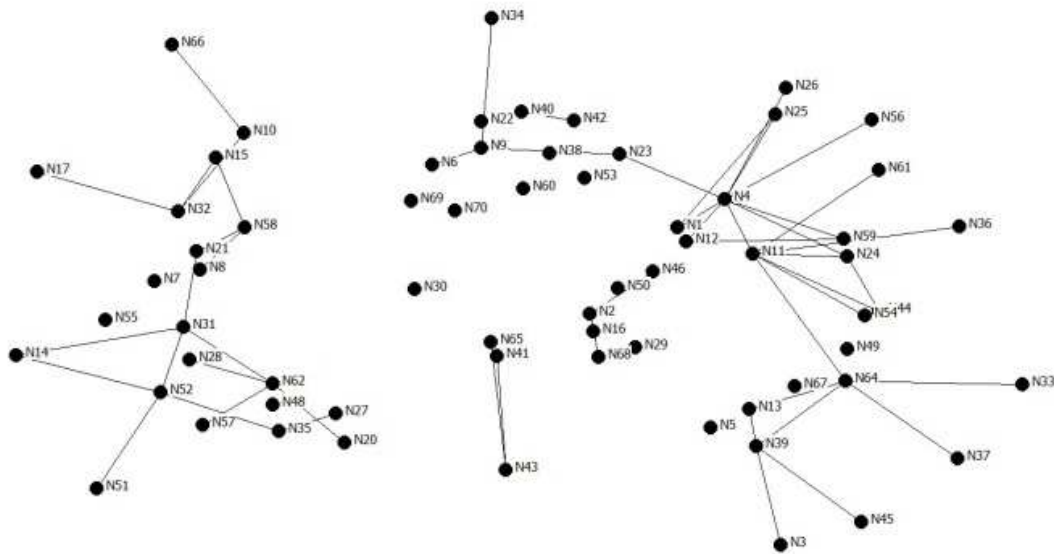
4.C. Network after attack based on the human capital approach.
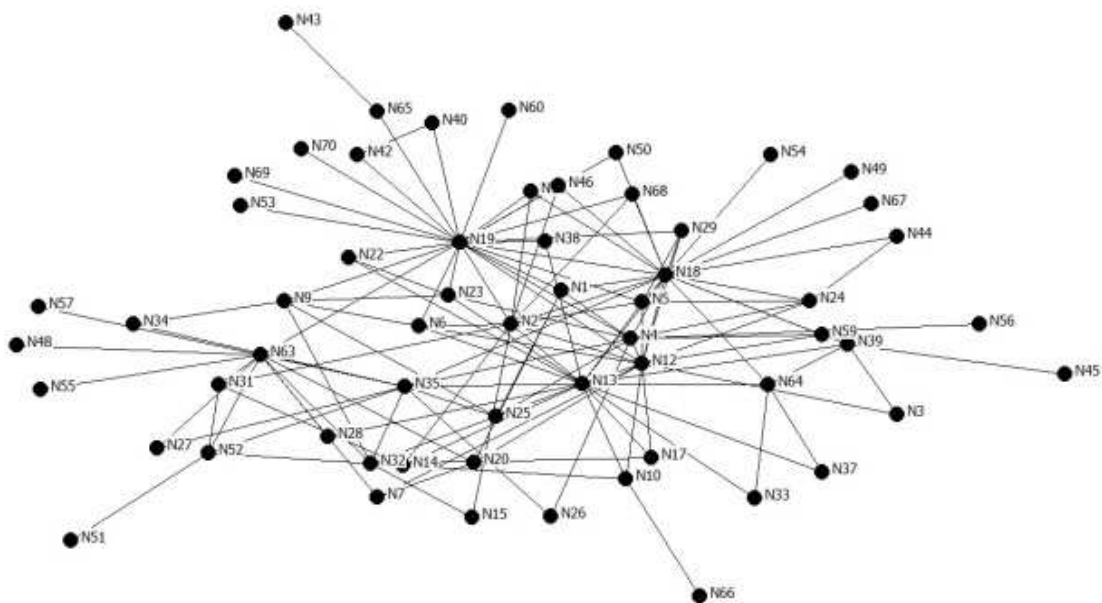
Source: Our processing of the data supplied by the D.D.A. (Local Anti-Mafia Investigation Department) of Cagliari.

4.2. "Il principe e la scheda ballerina" Operation

4.2.1. General analysis of the observed criminal network

The second criminal network analysed in this research is made up of a clan operating in a wide area in the province of Caserta and known with the unappropriate nickname of "clan dei casalesi" (Casalesi

clan)[23]. It is – as reported in the data taken from the warrant of arrest named "The prince and the dancing card" – a federate criminal group, which dominates in the province of Caserta. From the '70s of the last century until today it has exerted a great political and economic power, collecting a significant quantity of wealth and assets, that were re-invested in several activities through a wide network of relationships and the support of the population living in the area where the organization had most of its influence[24].

The interest of this organization in the public services field is related to the conquering logic of this dangerous criminal group. In fact, this field may not seem so profitable at first sight, or anyway not so lucrative as the fields of cement, agriculture, tourism and waste. However, at a deeper analysis, if we carefully look at the data supplied by the D.D.A. (Local Anti-Mafia Investigation Department) of Naples, we can see how the concerned field was used as a social legitimation instrument, i.e. as a means to increase its authority as well as the quantity of social capital available for the members of the organization. The reason for this activity has to be searched for in its ability to produce and grow the thick network of relationships connecting Mafia with politics, *business* and civil society in general and which represents the so-called "grey area" allowing the Mafia business to hide and to expand.

For this reason, the analysed *network* shows a high level of complexity, determined above all by the extreme variety of the individuals belonging to it (see Fig. 5). Among them there are not only the supporters of the Camorra group taken into account, but also Public organs, politicians, entrepreneurs, social cooperatives, public administrators and even people with no previous convictions. Among the several offences listed in the warrant of arrest, a dense network of relationships aimed at controlling the contracts and direct assignations in the field of public services is described. Moreover, illegal behaviours aimed at controlling the votes by some candidates to the political elections in Public bodies were illustrated. In particular, votes were influenced by paying amounts of money, through Mafia intimidations, illegal behaviours in the dynamics of the election committee and, finally, by promising the recruitment in some social cooperatives providing health and social services, whose reference partner, 1LL, was a local entrepreneur deemed to be close to some apical members of the Schiavone family *clan*.
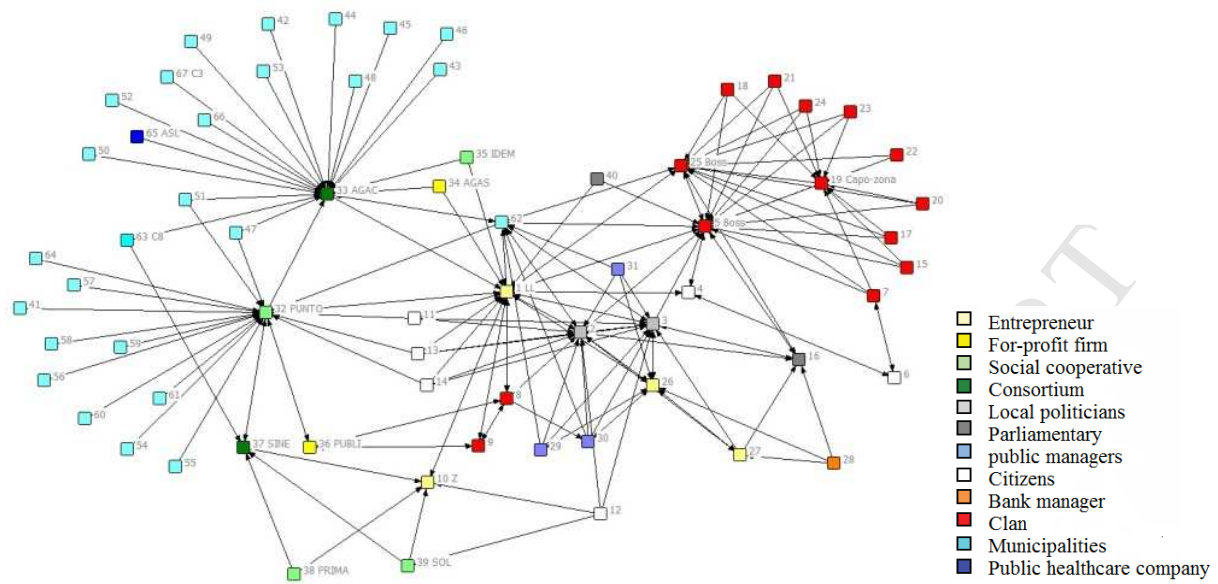
If we look at the morphology of the *network* we can identify three main cores: two of them are mainly *polycentric* but, while the central core is mainly made up of entrepreneurs, local politicians and civil servants, the one located above on the right side of the network is mostly made up of criminals, in particular of members close to the Casalesi cartel. Instead, the core located on the left side of the network is strongly *polarized* and above all made up of local bodies and individuals operating in the *non-profit* sector, in particular of social cooperatives, close to N1LL, supplying health and social services in several Municipalities. The three above-mentioned cores are connected one another through less stable and consolidated connections, but are more widespread and branched, which makes the network more dynamic and open to relationships with other sectors and environments of the civil society.

However, the criminal organization in itself (see Fig. 6) was mainly made up of the Schiavone family (whose prominent members are N5Boss, N25Boss and N19 area leader) and of the Bidognetti family (N8, N9), that since the half of the '90s has shared the undisputed domain of the *clan*. In carrying out the illegal activities of the organization an entrepreneur (N1LL) had a leading role: this was the legal representative of an Association of social cooperatives (33Agac) and, at the same time, also controlling other cooperatives indicated in the graph showed in Fig. 5 under numbers 32, 34 and 35. Such cooperatives recruited people "indicated" by local political candidates (N2, N3 and N16), who exploited N1LL for various activities to build and make their own election success grow. Moreover, the above-mentioned entrepreneur, thanks to his close relationships with the Schiavone family *clan* (N5Boss), used the protection and intimidation power of the criminal group as well as other "services" offered by its dangerous members, thus preserving an important market position in the field of the contracts for public services in the provinces of Naples and Caserta.

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[23] The use of the term "casalesi" (Casalesi clan) determined the assimilation of an entire population living in the Caserta area, in particular, in the city of Casal di Principe, to the criminal organization operating in such territories, seriously damaging the reputation and negatively affecting (stigma) social and economic relationships.

[24] See Parliamentary Investigation Committee on the Mafia phenomenon and on the other similar criminal associations (1994).

Fig. 5 -"Il Principe e la scheda ballerina" Operation. The connection network of the criminal organization (link analysis).

Entrepreneur
For-profit firm
Social cooperative
Consortium
Local politicians
Parliamentary
public managers
Citizens
Bank manager
Clan
Municipalities
Public healthcare company

Source: Our processing of the data supplied by the D.D.A. (Local Anti-Mafia Investigation Department) of Naples.

Fig. 6 - "Il Principe e la scheda ballerina" Operation. The relationship network of the criminal organization (SNA).
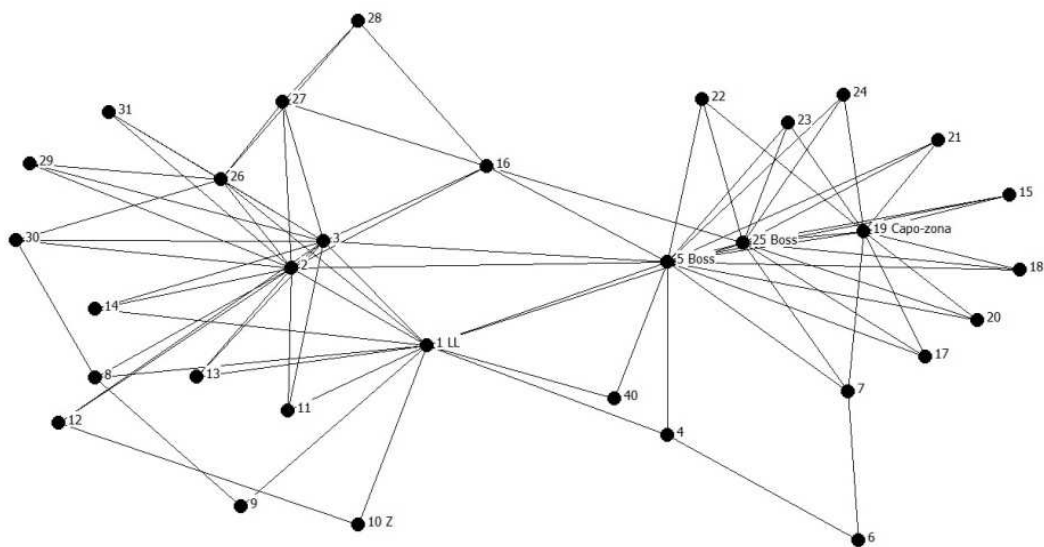
Source: Our processing of the data supplied by the D.D.A. (Local Anti-Mafia Investigation Department) of Naples.

N1LL contributed to the clan by paying it a part of its profits according to the managed turnover (protection money), by actually recruiting or by promising to recruit individuals close to the *clan* and, finally, by laundering money and other assets of illegal origin. In exchange for that, N1LL obtained contracts or assignments by several Municipalities in the province of Caserta, thus significantly increasing its turnover as well as the turnover of the companies belonging to the Association 33Agac (to which around 100 subsidiary cooperatives belonged for a total of 1,000 employees) and reaching an almost monopoly position in the field of public services.

Also the following people had a leading role in the organization:

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- N26, *ex* director of the technical office of a Municipalities in the province of Caserta that, thanks to the support of N16, set up a company in the name of his wife N27 (nominee) to financially support the construction of a great shopping centre;
- N28, bank employee in contact with N16, national politician, who from the outside took part in the activities of the criminal group by affecting the evaluation of the requests submitted to obtain the authorization to open the above-mentioned shopping centre;
- N2 and N3, politicians, connected with the criminals 5Boss (clan S), N8 and N9 (clan B), who exploited for various activities the cooperatives controlled by N1LL for "manipulated" recruitments aimed at building their own election success.

The above-mentioned relationship network generated a criminal system for the management of public services which actually did not supply the services planned by the qualified offices, but rather recruited health and social operators – under the supervision of individuals trusted by the *clan* or the local and national politicians themselves – in order to meet the above-mentioned individual needs of political and commercial exchange. A similar way of *recruitment* of the staff engaged in social policies highlighted the lack of professionalism of the operators in the concerned areas, thus causing situations of clear inefficacy towards the aimed public objectives as well as a general mistrust climate towards institutions, which still today helps slow down the growth and local development processes through the reconversion of the social capital used by the Mafia.

4.2.2. Topological analysis of the observed criminal network

Analysing the characteristics of the above-mentioned network we can detect (see Table 3) how it shows the structure of a network with a scale-free properties (identified by an *Alpha* value of 2,03, a *p-value* of 0,68 and a *goodness of fit* of 0,11), combined with the typical characteristics of the "small world" networks (in fact, the average path length is 2,22, while the clustering coefficient is 0,66).

The analysis of the centrality and brokerage measures (see Figures 7 and 8) further explains the characteristics and influence of the single actors inside the analysed network.

Fig. 7 – "Il Principe e la scheda ballerina" Operation. Distribution of the degree and betweenness centrality
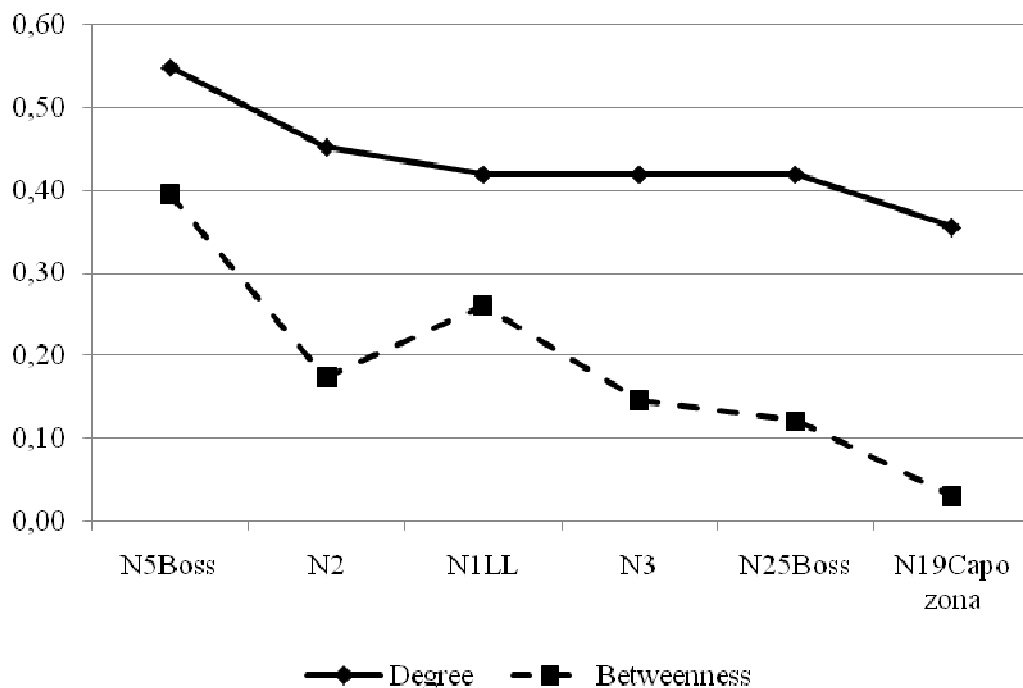
Fig. 8 – "Il Principe e la scheda ballerina" Operation. Analysis of the brokerage activity
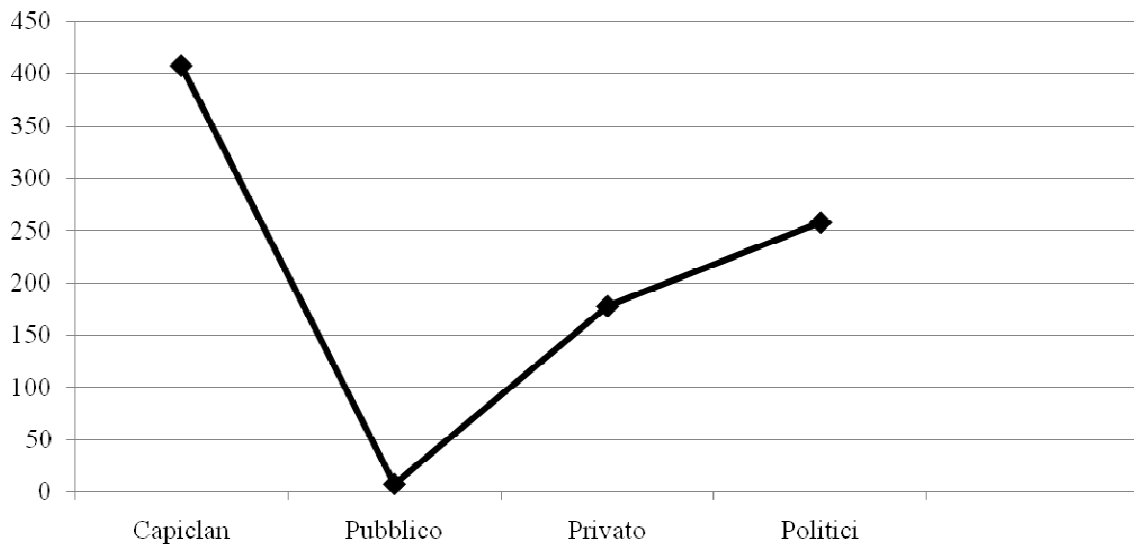
Source: Our processing of the data supplied by the D.D.A. (Local Anti-Mafia Investigation Department) of Naples.

In the 4 categories of individuals involved in the investigation (public employees; private individuals; politicians; clan leaders) it is easy to detect those who carried out a more intense intermediation activity. The analysis shows that the "strongest" *brokers* inside the network are, without any doubt, those who belong to the *clan* (N5Boss and N25), followed by politicians (N2 and N3) and private individuals (N1LL), while the intermediation activity of public employes, most of them working in the offices of the municipal districts involved in the activities carried out by the organization, is virtually irrelevant.

If we take into account the role of the several individuals inside the *network*[25], it is easy to understand how the actors representing the main source of interconnection among the several areas of the network are N1LL, N5 and N2. The centralization degree (*degree*), describing how the network depends on one of its leaders, also shows a good level of hierarchization (40,16%), determined by the presence of focal actors (*hubs*), while an intermediate value of the centralization index based on *betweenness* (37%) it shows the presence of actors who control the flows of information related to illegal activities (N2, N3, N1LL).

4.2.3. Analysis of the resilience level of the observed criminal network

Also in this case, in order to check the robustness level of the network, we carried out two attack simulations. The first attack ("random attack") aims at randomly removing only the nodes with a low *degree*, while the second attack ("*hub* selective attack") is based on the social capital approach and, therefore, aims at mainly neutralizing the actors characterized by a high value of *betweenness* (N1LL, N5, N2 and N3).

The results of the two attacks are listed in Table 3 and Figure 9. They show how (see Figures 9.B. and 9.C.), despite removing the 10 nodes with a degree between 2 and 3, the network maintains the original small-world and scale-free properties[26]. These characteristics potentially guarantee the operating continuity and regular functioning of the organization. Instead, the second attack, by removing at least 5 main *hubs* (N1LL, N5Boss, N25Boss, N2 and N3), makes the network break up in 7 components (see Fig. 9.C.). Therefore, at first sight the observed network seems significantly weakened, but as for various

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[25] Some actors also cover more than one role, sometimes carrying out the important function of "guardians" (or *Gatekeepers*), i.e. those who are on the borders of a group of individuals and able to control the "access" by those belonging to other groups, sometimes carrying out the function of "liason", when the intermediation activity concerns different areas of the *network*.

[26] The degree distribution indexes have the following values: *Alpha* = 2,51; positive *P-value* = 0,23; *Gof* = 0,12, while the "small world" indexes are: *Clustering Coefficient* = 0,63; *Average Path Lenght* = 2,13.

aspects it keeps on "enjoying a very good health". In fact, it is still possible to identify indicators of such excellent wellness status of the *network*:

    a)   removing the main *hubs* does not bring to the loss of the abetment of the institutions in the Municipalities concerned by the illegal activities of the clan; actually the network can still trust the civil servants working in the technical offices of the municipal districts who can push the administrative business to the benefit of the clan;

    b)   the network can still count on the representative-sponsor, at the national level, of the interests of the clan, a politician closely connected with the *Schiavone family clan*;

    c)   two influential individuals belonging to the *Bidognetti family clan* are still present inside the network (N8 and N9);

    d)   the redundancy in connections, typical of the family *clusters*, which guarantees that each area leader of the Schiavone family *clan* can be substituted and his/her businesses, knowledge and power can be transferred;

    e)   the rooting on the territory of all individuals involved in the criminal network (clan members, politicians, entrepreneurs, public officers).

Table 3 - "Il Principe e la scheda ballerina" Operation. Analysis of the network topology and of the effects produced by simulated random attacks

	Original network	*Random* attack	*Hub* selective attack
Size	32	22	27
Alpha	2,03	2,52	7 (components)
P-value	0,68	0,23	–
Gof	0,11	0,12	–
Clustering coefficient	0,66	0,63	–
Average path lenght	2,22	2,13	–

Source: Our processing of the data supplied by the D.D.A. (Local Anti-Mafia Investigation Department) of Naples.

It is clear that identifying and affecting only the most connected actors (the so-called "key players") of the criminal *network* and/or the nodes connecting the several groups and subgroups inside the network (the so-called "bridge connections" or "bridges") is not enough to break up its relationships structure. In order to be really effective, an attack strategy should identify and remove the minimum set of connections and nodes (*minimum cut-set*) having the precious knowledge, skills and technical abilities – or, in other words, human capital – of the criminal network.

Besides the removed *hubs*, which had a high "endowment" of human capital (in particular, we are referring to actors N1LL, N2 and N3), there are individuals who do not connect the various parts of the *network* one another, but significantly contribute to reach the criminal aims of the organization. Among these N16, the politician representative and sponsor of the Casalesi clan; the civil servants working in the technical offices of the several Municipalities interested in the illegal business of the organization (in particular, N30 close to the Schiavone family *clan*, N29 and N31); the engineer and entrepreneur N26, close to the politicians N2 and N3 due to family ties and, at the same time, with a close business relationship with the Casalesi *clan* for the development of a great shopping centre; N28, *ex* bank employee, able to find abetments and connivances inside the bank sector, and representative of the company to which was subcontracted the construction of the above-mentioned shopping centre.

It is easy to notice (see Figures 10.A. and 10.B.) that removing such nodes (through an attack based on the human capital approach) does not imply significant changes in the structure of the network. This remains integral and characterized by the same topology (see Table 4), preserving its initial features of robustness (as highlighted by the *Alpha* value, the *Goodness of fit* value and the p-value) and effectiveness (measured by the *Cluster Coefficient* and the *Average Path Length*). However, removing the above-mentioned actors, who identify individuals with particular competences, professional skills and relationships (for instance, think about the connections of N28 in the bank, the coverage of N16 or the services supplied by the public officers employed in the technical offices of the municipal districts) and who are difficult to replace for this reason, actually paralyzes the activities of the organization, at least in the short term, in an irreparable way.

Fig. 9 - "Il Principe e la scheda ballerina" Operation. Representation of the original network and of the simulated random attacks
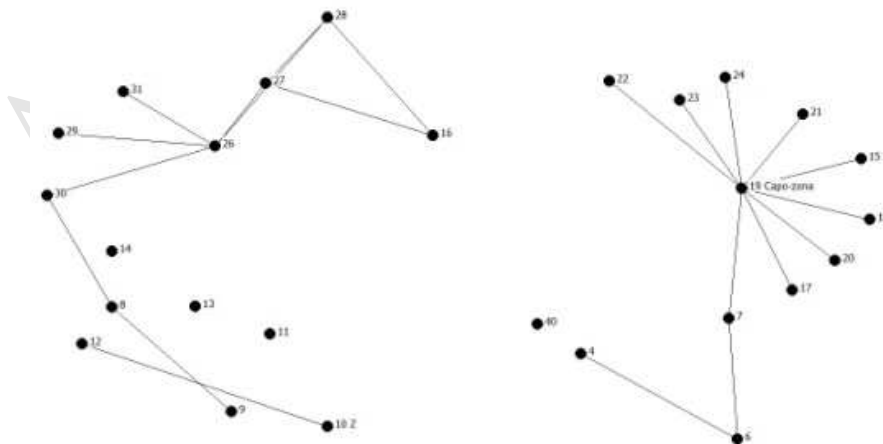
9.A. Original network.
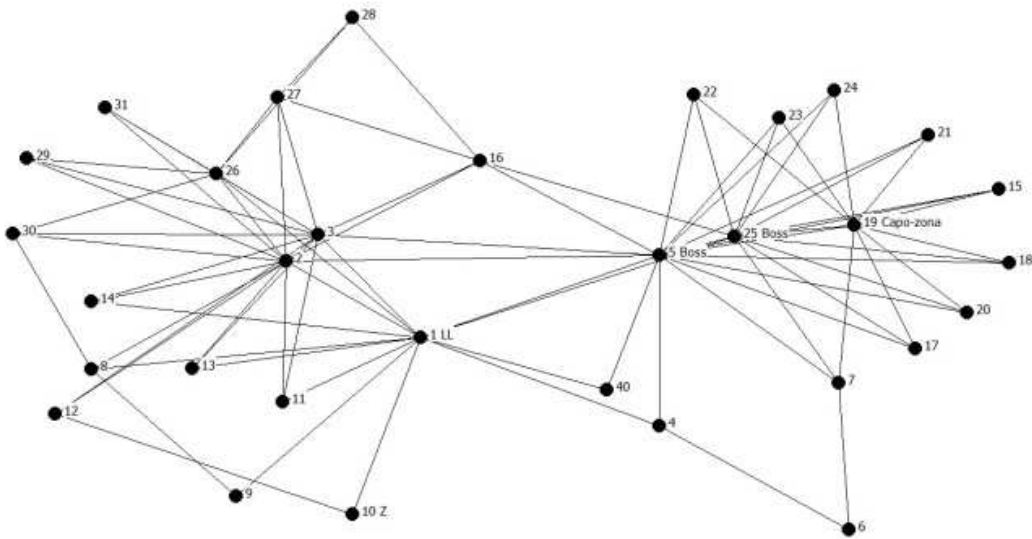
9.B. Network after random attack 1.
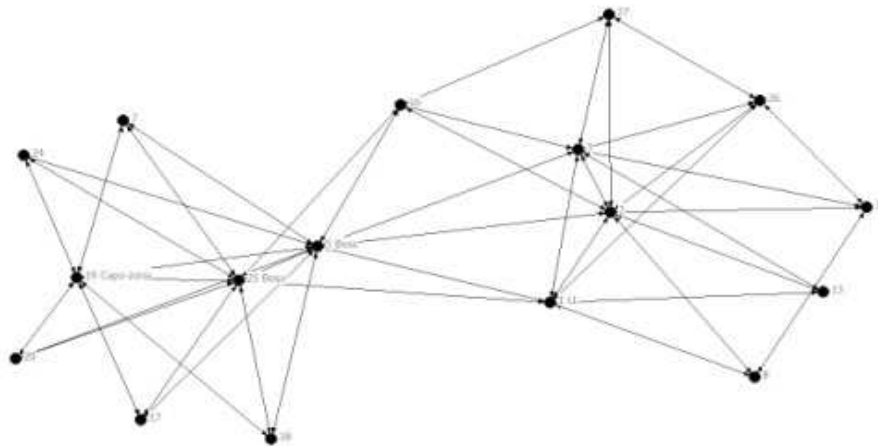
9.C. Network after selective attack .

Source: Our processing of the data supplied by the D.D.A. (Local Anti-Mafia Investigation Department) of Naples.

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The Ozgul and Edmer's algorithm once again does not allow us to have a clear perception of this situation (see Table 4). In fact, it just reduces by 13,07%, while the resilience index proposed in this research is much more effective, when it comes to measuring the damages caused by attacks based on the human capital strategy. In the concerned case, in particular, it even reduces by 39%, while we realize that the *random* attack aimed at only removing those nodes with a low *degree* made the resilience level of the criminal network increase. In fact, the resilience level increased by 3,19%, according to our algorithm, and by 4,6%, if calculated with the Ozgul-Edmer's algorithm.

Table 4 – "Il Principe e la scheda ballerina" Operation. Social capital and human capital strategies

	Original network	*Random* attack	Human capital attack
Arrested or killed criminals	0	6	6
Size	32,00	26,00	26,00
Alpha	2,03	2,52	2,10
P-value	0,68	0,23	0,82
GOF	0,11	0,12	0,11
Clustering coefficient	0,66	0,75	0,68
Average Centrality leader	0,45	0,50	0,46
Average Path Lenght	2,22	2,10	2,15
Average Human Capital*	1,91	1,91	1,00
Ozgul-Edmer's algorithm	1,46	1,53	1,33
Our algorithm	2,11	2,17	1,33

Notes: * The minimum value of the *Average Human Capital* is 1 (no individuals with special skills).
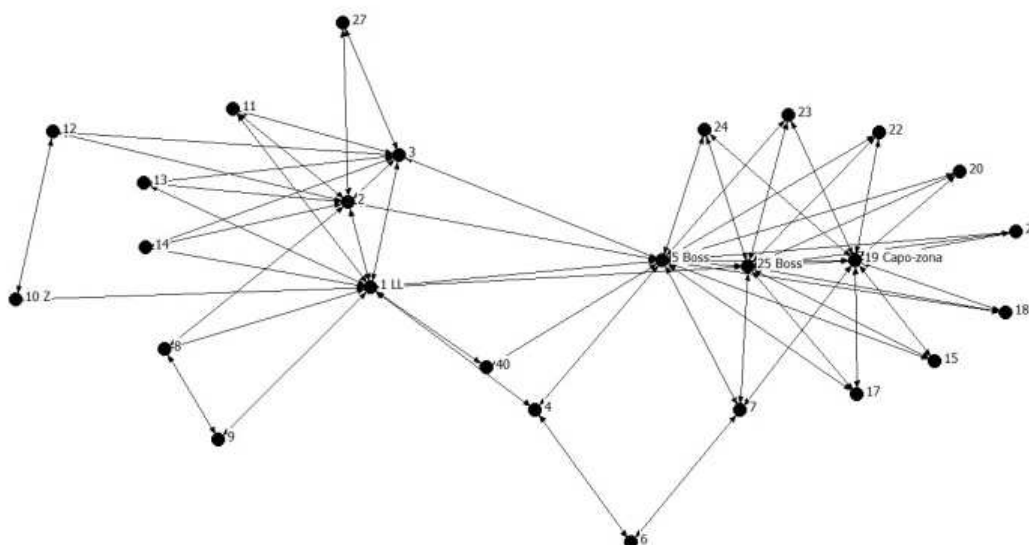*Source*: Our processing of the data supplied by the D.D.A. (Local Anti-Mafia Investigation Department) of Naples.

Fig. 10 - "Il Principe e la scheda ballerina" Operation. Representation of the effects produced by attacks based on the human capital strategy

10.A. Original network.
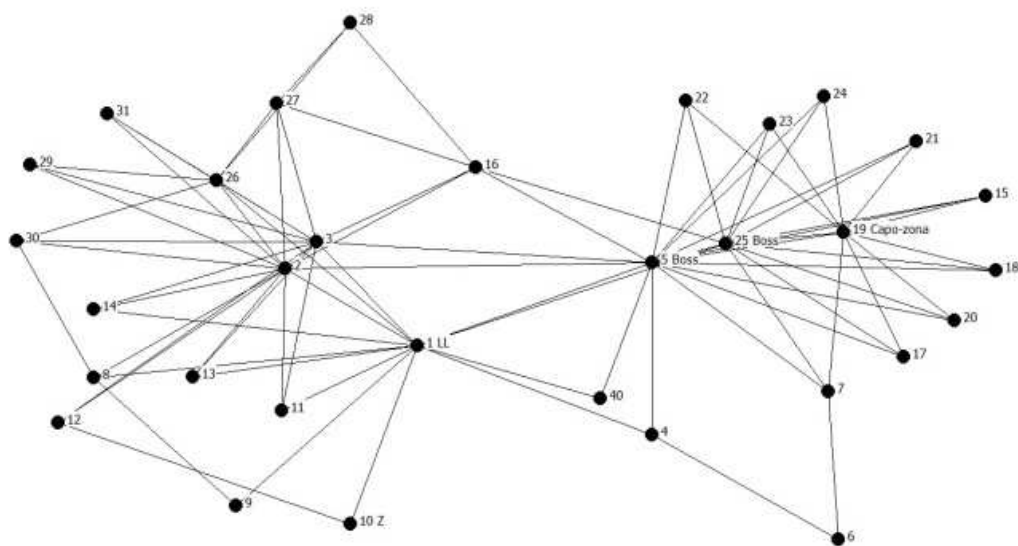
10.B. Network after attack based on the human capital approach.

Source: Our processing of the data supplied by the D.D.A. (Local Anti-Mafia Investigation Department) of Naples.

5. Conclusions

The analysis carried out in this research highlighted the high resistance and adaptation abilities usually characterizing criminal networks. In particular, the topological structure of two dangerous criminal organizations, employed in international drug trafficking and in supplying Municipalities with public services respectively, was analysed. The adopted techniques are the typical tools of the Social Economics and of the *Social Network Analysis*, which in the last years aroused a growing interest and rapidly spread even in the analysis of the public policies aimed at reducing criminality and enhancing *welfare* systems[27]. The data we used were taken from the investigational documents of the police as well as from the judgements issued by the ordinary judicial authority within two important crime-prevention operations which have been recently carried out.

Particular attention was dedicated to the concept of resilience and to the development of an appropriate *set* of indicators allowing us to measure the resilience level in an objective way and with reference to the structure of the interpersonal relationships inside criminal networks.

The aim of this research was to explore the potentials, the operating benefits as well as the limits of an extension of the application the SNA and of the analysis of complex networks to the study and development of public policies aimed at contrasting and repress Mafia-related phenomena. In particular, we tried to check if and to which extent contrasting strategies based on human capital may be used in combination with the strategies based on social capital to reduce or neutralize the resistance and adaptation abilities of criminal organizations.

The results show how the elements able to influence the resilience level of a certain criminal *network* are multi-faceted. In the last years crime literature tried to identify some of these elements, but there are further and several aspects whose importance is often underestimated, or even ignored, like the level of mutual trust as well as the knowledge, skills and technical abilities – or, in other words, human capital – available inside criminal networks. The analysis of such elements is fundamental in our opinion to develop a valid resilience index of criminal networks, but above all new and more effective policies contrasting organized crime. For example, the resilience analysis of criminal networks and the measure of the contribution of each of their affiliates or partners to strengthening of it, could help significantly to prove with factual evidence their participation in the criminal organization or even simple their closeness to it. The SNA and the economic theory of human capital could provide the appropriate tools to develop a set of indicators to measure in an objective way the degree to which each node contributes to the

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[27] See Raiteri (2010).

strengthening of the operational capacity of the criminal network or its resilience capacity[28]. In this sense the adoption of new and diversified repression policies based on the analysis both of human and of social capital could be profitable, as shown in this research.

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[28] These indicators would act as "factual indicators" ("indicatori fattuali", o *facta concludentia*), or as juridical evidence of the criminal conduct, such as those ones used by the Italian jurisprudence to infer the stable interpenetration of a person in the organizational network of a criminal group or its simple "external collaboration" in the affairs and to the purposes pursued by a Mafia-type association. For further details on the notion of "factual indicator" and the fellony of "external support/collaboration with a Mafia-type criminal association" ("concorso esterno in associazione mafiosa") developed by the Italian jurisprudence, see Visconti (2000, 2005, and 2015).

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Highlights

- The paper proposes the implementation of new and more effective policies to contrast organized crime.
- The paper develops a simple algorithm to estimate the resilience of criminal networks and to compare the effects of different attack strategies used by police forces.
- Obtained results show the high resilience ability of criminal organizations, suggesting A virtuous combination of structural and skill analysis.
- The paper suggests public policies and legal instruments to discourage and fight all kinds of mafia contiguity currently pursued with toothless weapons.

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