

RESEARCH ARTICLE

Network analysis in peace and state building: revealing power elites

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Abstract

This paper examines the potential role of network analysis in understanding the powerful elites that pose a significant threat to peace and state-building within post-conflict contexts. This paper makes a threefold contribution. First, it identifies a caveat in the scholarship surrounding international interventions, shedding light on shortcomings in their design and implementation strategies, and elucidating the influence these elites wield in the political and economic realms. Next, it delineates the essentials of the network analysis approach, addressing the information and data requirements and limitations inherent in its application in conflict environments. Finally, the paper provides valuable insights gleaned from the international operation in Guatemala known as the International Commission for Impunity in Guatemala, which specifically targeted illicit networks. The argument asserts that network analysis functions as a dual-purpose tool—serving as both a descriptive instrument to reveal, identify, and address the root causes of conflict and a predictive tool to enhance peace agreement implementation and improve decision-making. Simultaneously, it underscores the challenge of data analysis and translating network interventions into tangible real-life consequences for long-lasting results.

Policy Significance Statement

This paper highlights the potential of network analysis in helping to identify, forecast, and address conflict, which enhances peace agreement implementation and improves the evaluation of peacebuilding activities. The study underscores the importance of data-driven approaches in fostering stability and peace, drawing insights from network findings in the International Commission for Impunity in Guatemala case. The insights of this paper can be useful for decision-making processes in diplomatic missions and operations, for the United Nations, the Security Council panel of experts, and for monitoring nonprofit organizations and contributing to the metrics for conflict prevention early warning systems.

1. Introduction

Domestic and transnational criminal networks and influential organizations are usually the underlying root cause of conflict, and pose a significant threat to peace, the rule of law, human rights protection, and government institutions' stability (UN, 2005; Andersen, 2016). Dominant factions within conflicts often further their objectives through corruption and, on occasion, violence (MacLachlan, 2017). These groups

operate on specific interests upheld by networks of individuals who exploit the prevailing context. Sometimes, this self-serving exploitation results in a vicious cycle that intensifies the conflict. This dynamic is particularly heightened in societies enduring prolonged civil wars, where the prevailing norms and regulations have emerged amidst the ongoing conflict itself (Collier and Hoeffler, 2004; Andersen, 2016; Schwartz, 2020). Legal and illegal activities intertwine within these intricate networks in such environments, involving entities that gradually amass control and power over time. Power structures exert significant influence over the trajectory of peacebuilding and state-building processes during and after conflicts. In this study, we refer to these structures as the influential elites capable of shaping peace outcomes, regardless of their engagement in criminal or illicit activities and their association with the public or private sector, be it formal or informal. In order to explore elite dynamics, it is critical to use information and data analytics, particularly network analysis, as a powerful tool for uncovering relationships and anticipating outcomes. The network analysis approach offers valuable insights that can guide efforts to prevent and combat crime and corruption through the definition, measurement, modeling, and control of various analytics (Sparrow, 1991; Framis, 2014; Carrington, 2016; Luna-Pla and Nicolás-Carlock, 2020). It can be applied to situations where power structures resort to violence to maintain political and territorial control, redirect public funds for electoral campaigns, manipulate the judiciary, and facilitate illicit activities such as money laundering and tax evasion. Under such circumstances, where access to reliable evidence-based information may be compromised or masked, the significance of network analysis and the application of statistical models becomes paramount. The paper makes a threefold contribution to peace and state-building scholarship and practice. Firstly, it underscores the shortcomings in the existing peace and state-building literature, emphasizing the imperative to gain a more nuanced understanding of the role played by influential elites in conflicts or post-conflict environments. Secondly, it explores the network analysis approach's essentials, addressing the information and data requirements and limitations inherent in its application in such environments. Thirdly, the paper provides valuable insights drawn from an international operation led by the International Commission for Impunity in Guatemala (CICIG), which was uniquely designed to target illicit networks through the judicial prosecution of crimes and corruption between the years 2007 and 2019, while simultaneously aiming for state-building objectives (Waxenecker, 2019; Hallock, 2021; Zamudio-González, 2021; Trejo and Nieto-Matiz, 2022). Approaching the practical realm, this case's insights show the potential of initiating discussions on translating network interventions into tangible applications in areas such as judicial prosecution, prevention, and the restructuring of economic incentives. <return>

2. Promoting peace and state-building by targeting influential elites with data

The field of peace and state-building scholarship is increasingly recognizing a challenge in understanding influential groups and powerful networks, particularly at the intersections of criminals, governments, and security forces. Concurrently, the practical domains of diplomacy and policymaking —where conventional elements such as information, transparency, and, more recently, big data and statistics are utilized in the design and orchestration of peace operations- are calling for sophistication of tools. This shift involves the integration of analytical methods and multidisciplinary expertise. It is within this momentum, the rising demand for innovative responses, and the necessity for assessment tools for international intervention outcomes that network analysis becomes feasible to showcase its potential. This is particularly true when complemented by other methods that leverage qualitative valuable insights in tandem.

2.1. Background on the use of information and data

International institutions have a well-documented history of utilizing information transparency strategies to shape informed security policies, thereby fostering peace and aiding state-building efforts. When used properly in certain contexts, transparency can mitigate tensions, resolve crises, and empower peacekeepers in achieving their objectives (Lindley, 2007). During cooperation and bargaining operations or missions, these institutions have employed information strategies, turning to a variety of mechanisms to

both acquire and capitalize on state-level and global information. These mechanisms include but are not limited to exchanging insights at conferences, working groups, and summits, leading informational campaigns, and sharing intelligence among the conflicted sides.

Big data has revolutionized the approach to information usage in the sphere of international conflict resolution, aiding societies in comprehending and prepping for humanitarian crises and conflicts (Letouzé et al., 2013; Meier, 2015). The vast array of information, including voice recordings, videos, and data from commercial satellites and sensor networks, allows international institutions and decision-makers working towards peace objectives to custom-fit decisions and responses (Letouzé et al., 2013; Pencheva et al., 2018; Wählich, 2020). Moreover, advancements in digital media technologies, artificial intelligence, and machine learning tools also have played a critical role in understanding conflicts, facilitating communication with affected populations, and the advancement of sustainable development goals (Hassani et al., 2021). Natural language processing, in particular, has proved to be a potent tool for conflict mediators and peacebuilders. It empowers them to engage in real-time, large-scale dialogues with the public, interact digitally in various languages, filter misinformation, and monitor political stability trajectories, thereby enabling early warning systems (Donnay, 2017; Hassani et al., 2021; Alavi et al., 2022).

Data analytics represents a new frontier for peace and state-building operations, aiming to infuse data with the precision that aids in identifying relationships that perpetuate conflict and in implementing predictive measures for conflict prevention and peace resolution enhancement. These analytical tools, previously applied in fields like crime and conflict forecasting, intelligence activities, and fraud detection (Sparrow, 1991; O'Brien, 2010; Perry et al., 2013; Baesens and Veronique Van Vlasselaer, 2015), can serve as accessible resources for international institutions, broadening their impact and efficacy in targeting criminal networks and achieving realistic results.

2.2. The need for analytical tools to understand conflict

When countries underpass violent conflicts, wars, and internal political and security turmoil, the peace processes and the reconstruction of governmental institutions are afflicted by the elites' abuse of power in control of territories and of political power. Corruption, as a generalization of licit or illicit activities, has been extensively researched as a contributing factor to the deterioration of state institutions and political unrest (Le Billion, 2005), with significant implications such as fueling conflict and violence (Shleifer and Vishny, 1993), undermining electoral systems, eroding the rule of law institutions and culture, and colluding with security and enforcement forces (UN, 2005; MacLachlan, 2017; WB, 2020). Such environments severely impact economic development; they create an uneven playing field that strengthens powerful elites, erodes trust in public institutions, and diminishes social cohesion. Because powerful elites operate unchecked and often serve as gatekeepers, tackling corruption networks in criminal environments often uncovers the root causes of conflicts and provides means to identify, target, and address these complex illicit dynamics, such as the collusion between powerful criminal actors and state institutions and individuals in opaque financial systems (Trejo and Nieto-Matiz, 2022).

However, it has often been claimed that international efforts fail to acknowledge the interests of entrenched political and powerful actors who benefit from a weakened state during or after conflict, and even donors who prioritize strengthening the criminal justice system may overlook the intricate social dynamics that underpin corruption (Gavigan, 2011; Heathershaw, 2012; Simon, 2023). Contemporary critiques of peace and state-building operations have highlighted the lack of analytical tools available to understand the origins of conflict and political unrest, as well as the dynamics of criminal and illicit networks (Holt and Bouch, 2009; Cockayne and Lupel, 2011), which can have ambiguous consequences for the sustainable transformation of political, economic, and post-war societies (Berdal and Davies, 2013).

Assessing and predicting conflict and political stability for peace prevention is a growing theme in international public policy and the global debate of conflict forecasting (O'Brien, 2010; Gnanguenon, 2021; Rød et al., 2023). The existing work claims that an analytical approach is crucial for predicting civil war occurrences and events that can exacerbate or mitigate political crises and the configuration of factors

driving instability. It aims to identify patterns in the complex interactions among players, which is essential knowledge for achieving peacekeeping objectives (Lustick et al., 2004; O'Brien, 2010; Ward et al., 2010; Donnay, 2017) and for the design of sustainable peace mandates (Wählisch, 2020). While the analysis of social interactions has been integrated into various empirical methods and conflict modeling networks, including agent-based models, natural experiments, and diverse analytical instruments for explicating and predicting conflict (Collier and Hoeffler, 2004; Lustick et al., 2004), the application of network analysis focused on elite groups is yet to be utilized as a parameter in early warning systems for quantitatively predicting conflict. Such systems traditionally rely on predictive maps and rankings (O'Brien, 2010; Rød et al., 2023). The need for frontier research to look at underlying power structures has also been highlighted, particularly in hybrid international missions (Gavigan, 2011; Hallock, 2021; Zamudio-González, 2021), such as Guatemala's CICIG. Hence, it is crucial to analyze the influence of international interventions on elites and powerful networks in conflict zones, providing findings and insights for the design and implementation of mission agreements.

2.3. Advancing peace and state-building with network analysis

Contemporary state-building international operations vary from country to country and from conflict type but often include judicial reforms, commitments to strengthening political structures, assistance in prosecution and law enforcement and anti-corruption strategies, seeking long-lasting stability and peace (Spector, 2011; Cheng and Zaum, 2012) and decrease of criminality in the host state (Holt and Bouch, 2009, Trejo and Nieto-Matiz, 2022). An international intervention aimed at dismantling illicit networks becomes warranted when years of conflict have eroded state institutions, resulting in resource scarcity, tax collection deficiencies, deep-seated involvement of organized crime syndicates in governance, and participation of violent gangs, groups, or cartels in illicit activities. These factors collectively undermine public confidence in government, and compromise the authority and legitimacy of the state (Brands, 2010; Spector, 2011; Zamudio-González, 2021; Trejo and Nieto-Matiz, 2022). To address these sophisticated operations, network analysis can be used to evaluate potential outcomes based on the anticipated transformation and crisis management of the environment from one riddled with crime and violence to a more secure and non-criminal landscape (Masys, 2014).

The use of data analyzed with computing seeks to add precision and breadth to the possibilities of definition, measurement, and quantitative control from the understanding of the systemic phenomenon in social problems, crime, and corruption (Framis, 2014; Barabási, 2016; Luna-Pla and Nicolás-Carlock, 2020). Several studies have used this approach to detect and understand terrorist networks according to each network structure and function (Morselli et al., 2007; Leuprecht and Hall, 2014; Campedelli et al., 2019). When used in criminology and intelligence (Strang, 2014; Cunningham et al., 2016; Tayebi and Glässer, 2016; Burcher and Whelan, 2018), this approach illustrates links and graph criminal relationships between people, which contributes to formulating research hypotheses and policing effectively (Sparrow, 1991; Carrington, 2016; Tayebi and Glässer, 2016; Burcher and Whelan, 2018). The approach offers detailed insights into the intricate workings of criminal and corrupt activities while also addressing critical criminological questions, such as linking activity to individuals when the relevant information is available (Felson et al., 2006). Recently, this methodology has effectively unveiled interconnections among criminal acts within a community of offenders. Establishing links between crimes like corruption, drug-related offenses, and street-level criminality, substantiates the frequent association of corruption with other criminal activities (Heiler et al., 2023; Bright et al., 2024).

The quantitative analysis of networks in cases of past or ongoing conflicts has the potential to generate metrics to identify and measure the structure, levels of the organization, dynamics of the network, roles within it, concentration, self-organization, and links of what is being analyzed (Barabási, 2016; Marin and Wellman, 2016). However, the formulation of metrics, understanding of power distribution dynamics, and devising progress indicators within international collaborative endeavors must align with the values and principles outlined in intervention agreements. Strategic and operational guidance remains crucial in this pursuit (Gavigan, 2011; Heathershaw, 2012).

3. Data requirements and network analysis in conflict and violent contexts

This section describes the essential principles of network analysis while introducing the constraints and objectives inherent to this analytical tool. It addresses the limitations of the analysis, the intended objectives, and the intricate challenges surrounding information and data collection, particularly within conflict zones, encompassing both formal and informal relationships. The objectives of employing network analysis are intricately linked to the chosen analytical strategy, data prerequisites, and the hurdles and constraints concerning data and information gathering, refinement, and maintenance. These factors significantly impact the translation of theoretical insights into practical, real-world solutions, and policy strategies. Therefore, a comprehensive grasp of the intended goals becomes imperative in devising an effective network analysis approach and managing the complexities associated with data interpretation and findings.

3.1. Fundamentals of network analysis in addressing social issues

Network analysis is essentially a structured method that employs principles from statistical physics and computer science to model and interpret diverse relationships within various datasets. These quantitative tools serve to describe, quantify, predict, model, map, and reproduce specific environments, sometimes reflecting real-life relationships and activities. Initially utilized to explore natural and physical phenomena, this approach has recently expanded its scope to encompass social issues and humanities, driven by advancements in computing sciences, knowledge sharing, and cross-disciplinary problem-solving (Ball, 2003; Caldarelli et al., 2018; Gershenson et al., 2020).

Phenomena like violent conflict, corruption, and crime often stem from socio-political and economic systems that can be conceptualized as networks comprising individuals, institutions, organizations, and activities, as demonstrated in network analysis (Morselli et al., 2007; DellaPosta, 2017; Ribeiro et al., 2018). Understanding the interrelations within these environments is complex due to their temporal evolution and the inability to explain behavior solely by isolated components (Ball, 2003; De Domenico et al., 2019). Network analysis serves as a key tool to comprehend such behavior, representing players as nodes and their relationships as edges. For instance, in a social network, an edge might signify a friendship, a familial tie, or another form of social interaction (Scott, 2017). Nodes can also represent diverse relationships within a bipartite network, such as an individual connected to a business organization as a stakeholder, and that business linked to a government institution through a contract (Wachs et al., 2020; Nicolás-Carlock and Luna-Pla, 2023). These interconnections among nodes can take various forms and quantities, from the formation or absence of triads to networks consolidating into a single large component, as exemplified in Figure 1.

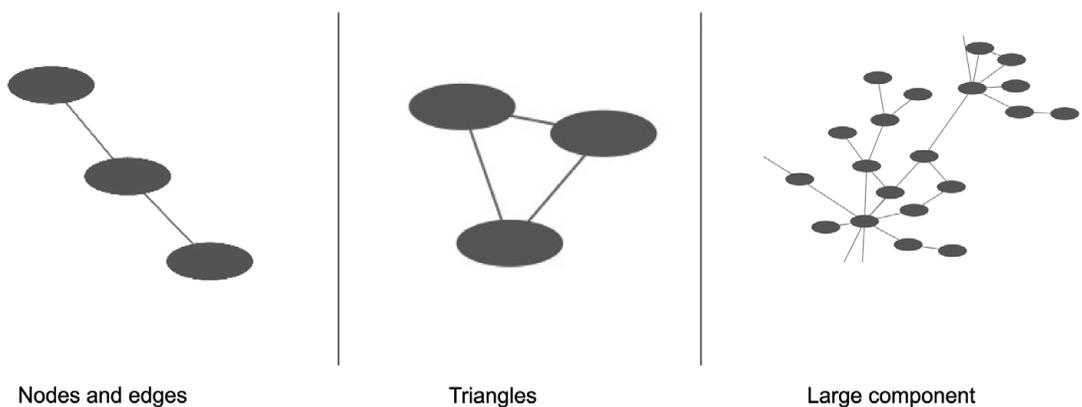


Figure 1. Examples of configuration in a network.

Network analysis extends beyond merely linking nodes and creating graphical representations of interconnected actors, entities, or activities within conflict-laden environments. It harnesses a spectrum of tools to evaluate the network's density, indicating the overall linkage among nodes, and its robustness against interventions and disruptions (Barabási, 2016), as it possesses the capability to reorganize itself (Duijn et al., 2014; D'Orsogna and Perc, 2015). The dynamics within networks, whether human or inanimate entities, and their nonlinear structural evolution under specific conditions render the system highly unpredictable, and challenging to control (Bar-Yam et al., 1998).

Metrics examining the structure and dynamics of corruption and criminal networks have provided insights into various forms, including hierarchical or familial networks, organized crime, diverse illicit markets (Morselli et al., 2007; Framis, 2014; DellaPosta, 2017), and even conspiracies and favoritism (Nicolás-Carlok and Luna-Pla, 2021; Falcón-Cortés et al., 2022). The structure and dynamics of these networks evolve in response to changes and regulations within their environment, shaped by a multitude of factors and cohesive actors (Barabási, 2016; Carrington, 2016; Campedelli et al., 2019; Luna-Pla and Nicolás-Carlok, 2020). The goal of network analysis is to grasp the properties of these systems, the collaborative behavior of interconnected components, and the implications of behavior on a macro scale. This understanding is crucial to prevent misinterpretation of the causes of phenomena (Bar-Yam et al., 1998; Gershenson et al., 2020), significantly impacting strategies developed to intervene in these networks, whether in a controlled laboratory setting or real-life intelligence operations.

In a network analytical model, signs of network destabilization may manifest as a decline in the network's information flow rate, reduced operational efficiency, or a significant slowdown in decision-making processes (Duijn et al., 2014). Similarly, disrupting a network involves identifying and eliminating specific nodes or edges that, upon removal, result in the least cohesive network, effectively sabotaging it or isolating certain nodes (Tayebi and Glässer, 2016). For example, findings from studies on criminal interventions suggest that imprisoning high-profile criminals and targeting specific nodes and edges can profoundly influence the network's reorganization (D'Orsogna and Perc, 2015; da Cunha and Gonçalves, 2018), potentially bolstering illicit activities and escalating violence when disrupting clusters (Contreras Velasco, 2023).

It's important to note that networks often display substantial resilience against targeted disruption strategies, sometimes transforming into even more robust and resilient configurations following perturbations (Framis, 2014; D'Orsogna and Perc, 2015). Consequently, evidence indicates that interventions are more likely to succeed when executed during the initial stages of network growth before it has had the chance to organize or reorganize for maximum resilience (Duijn et al., 2014).

Over an extended period, criminologists have utilized analytics to study network behavior, guiding decision-making, targeting specific nodes, predicting future occurrences, and aiding in prevention—particularly advantageous in law enforcement (Sparrow, 1991; Carrington, 2016). Previous analyses have revealed that network intervention extends beyond punitive actions, encompassing the disassembly or disruption of the network while simultaneously addressing underlying economic root causes, preventing recurrence, and altering the environmental conditions contributing to its formation. This process might involve rehabilitating individual behavioral patterns or building capacities and economic conditions to counteract systemic illicit practices (D'Orsogna and Perc, 2015; da Cunha and Gonçalves, 2018; Prieto-Curiel et al., 2023). Furthermore, a deep understanding of complex financial and social motivations can facilitate severing ties between corrupt entities and the ultimate beneficiaries of such illicit agreements (Costa et al., 2021; Diepenmaat, 2021). Such insights could significantly enhance conflict forecasting and assessment endeavors.

3.2. *Optimal data types for relational analysis*

Finding data conducive to the development of network analysis in criminal and conflict contexts hinges on aligning goals, aims, or hypotheses. For instance, this quest could involve a forensic investigation targeting specific individuals, deciphering relationships between distinct groups, or uncovering connections linking criminal activities and governmental bodies. Whether aiming to understand historical events

or current undertakings, the data essential for analysis seldom resides within a single accessible source, encompassing all necessary elements for drawing conclusions.

As a result, crafting datasets typically involves amalgamating information from diverse sources to create comprehensive sets for descriptive and predictive network analysis (Baesens and Veronique Van Vlasselaer, 2015). This process contends with the unstructured nature of the data, which refers to vast amounts of information lacking predefined patterns, thereby posing challenges in search and analysis. Unstructured data stems from various sources and file formats, including social media, documents, communication transcripts, and technical reports. The task of constructing datasets from unstructured data poses several hurdles, primarily the need for specialized tools to standardize and organize it.

Amidst the realm of unstructured data, significant insights can be derived from publicly available sources like news stories, technical reports from institutions or non-profit organizations (O'Brien, 2010), and investigative journalism revealing corruption scandals (Ribeiro et al., 2018; Luna-Pla and Nicolás-Carlock, 2020). Additionally, governmental sources like judicial case files, evidence, and open data platforms offer pertinent information, including historical crime records from security and police authorities (Perry et al., 2013), unveiling the complexities within elite networks linked to illicit activity.

Economic data is also crucial to understanding incentives and reorganizing dynamics within networks in a larger financial context. Tracking individuals' economic wealth and using transactional data (when available) becomes immensely valuable. This includes information related to consumer practices, such as the illicit enrichment of elites. Such data allows for clustering and weighting relationships within the network, enabling analysis of variables like recency, frequency, and monetary amounts. It plays a vital role in identifying and gathering evidence for cases involving money laundering, fraud, and embezzlement, all of which contribute to conflicts, violence, and organized crime through systemic corruption (Baesens and Veronique Van Vlasselaer, 2015).

Economic data is closely linked to contractual information, which encompasses contracts, bank account records, memberships or subscriptions, and business bylaws (some of which are publicly available depending on the jurisdiction). This data forms the basis for identifying various variables, including relationships between buyers and suppliers, instances of illicit enrichment and embezzlement, connections between governments and networks engaged in illicit activities or power control, individuals occupying multiple roles within these networks, instances of tax avoidance, and company misuse (Baesens and Veronique Van Vlasselaer, 2015; Luna-Pla and Nicolás-Carlock, 2020; Wachs et al., 2020).

Another category of data, frequently utilized in intelligence strategies and discoverable through investigative efforts, pertains to communications found in social networks, phone records, and emails. When these communications are part of private registries, they remain confidential to the public, accessible only by law enforcement authorities during investigation processes. However, they might also surface in disclosed records, such as trials or through information requests to governments. While economic and communication information is typically confidential to journalists or nongovernmental organizations, ethical investigations conducted by government authorities can uncover crucial links between individuals, their roles, and their influence on decision-making processes within various operations.

3.3. Limitations in analytical approaches for powerful networks

Learning from criminal network studies, it is possible to identify certain considerations that can bias network analysis results and pose substantial challenges for both scientists and technicians, whether they're implementing these methods within or outside governmental spheres. For anyone researching powerful networks and performing network analysis for practical purposes presents a challenge owing to the inherent unpredictability of situations and behaviors. Consequently, even the most advanced models encounter difficulty in forecasting changes in levels of political violence and the emergence of new security outbreaks in regions historically known for peace (Tayebi and Glässer, 2016; Rød et al., 2023).

From a network perspective, research has to take into account that illicit activities mutate over time as players adapt and learn from mistakes (Sparrow, 1991; Grabosky and Duffield, 2001; Simonofski et al.,

2022), networks' composition and dynamics evolve, individuals and agencies exhibit volatility or camouflage, and self-organization and emergent behavior within the network make it a complex phenomenon. Moreover, in conflict-ridden and criminally violent contexts, networks arise from the interconnectedness of illicit events, activities, individuals, and groups, which gradually develop patterns over time (von Lampe et al., 2006; McGloin and Kirk, 2010), and because of the links with public or private organizations to conceal their activities, maintain control over the territory, and protect their core members (Gambetta, 1993; Morselli et al., 2007).

In addition, it is worth recognizing that information related to criminal activities is often obscured by the involved actors (Zamudio-González, 2021). Information in judicial cases can be incomplete or may leave loose ends (Sparrow, 1991; Jones et al., 2020), and it is biased by the investigative focus (Jones et al., 2020). The accuracy of information is also affected by limitations such as the inability to include complete results from interrogations, informants, wiretapping, and financial investigations. Due diligence issues can arise in fraud detection procedures (Baesens and Veronique Van Vlasselaer, 2015; Pencheva et al., 2018; Tombal and Simonofski, 2021), as well as in investigations conducted by criminal prosecutors, that can distort the real facts. Moreover, corruption activities are often underrepresented in data due to logical and procedural challenges, as in most countries, corruption is harder to prove than a criminal offense. Likewise, security and conflict-related information often remain classified and challenging for non-governmental entities to access in numerous countries (Gnanguenon, 2021). Additionally, certain actions go undocumented when they are arbitrary and lack accountability.

Conflict-affected governments are typically weak, plagued by high levels of corruption within the judiciary and police forces, and have constrained budgets, limited credibility among citizens, and unclear mandates. These contextual factors contribute to a lack of reliable data and accurate information for peacebuilding institutions engaged in analytics (Letouzé et al., 2013). Furthermore, the available information often overlaps or contradicts itself, and there are political barriers to information transparency (Lindley, 2007). Government agencies in conflict-affected states may also produce disconnected and mismatched information, further complicating the analysis process (Lindley, 2007).

As an empirical study, understanding criminal network behavior commonly suffers from selection bias, lacking data on undetected or unresolved criminal cases, thereby failing to capture the complete spectrum of network dynamics or covert operations (Morselli et al., 2007; Heiler et al., 2023). Indeed, the analysis's breadth is constrained by available data, offering only partial glimpses or fragmented depictions that fail to encapsulate the entirety of the conflict landscape. Hence, employing these tools necessitates complementing them with traditional policy and contextual analysis methods, alongside invaluable insights from individuals possessing firsthand experience and on-ground knowledge of the situation.

In uncontrolled environments requiring intervention through peace and state-building policies, the verifiability of information becomes crucial. Analytical tools must effectively discern signals from the noise of information (Strang, 2014), particularly as data often stems from informal sources, whistleblowers, informants, or witnesses. Nonetheless, it's vital to contextualize these outcomes within each specific case, as their applicability might be constrained by contextual elements.

3.4. Ethics, misuse, and privacy concerns in network analysis

In conflict or post-conflict scenarios, ethical considerations and privacy concerns become critical when handling unstructured data related to social issues and political instability, especially for conflict prevention purposes. Curating data demands adherence to regulatory standards, ensuring compliance with transparency and information access regulations.

On the one hand, guaranteeing data quality involves verifying its availability, reliability, usability, and relevance for network analysis (Cai and Zhu, 2015). Neglecting this process can pose the risk of producing biased narratives, leading to inaccurate outcomes (Carrington, 2016) and misguided decision-making misaligned with unverified data. On the other, the confidentiality of data is covered by country legislation on data protection and privacy, besides the human rights international law protection. This poses restrictions from the process of collection of data, to management and publishing, that apply to journalist

groups, non-governmental organizations, and scholars who rely on publicly accessible information. Alternatively, researchers can use relational data obtained from public sources, such as career resumes, criminal records, and social media interactions, which can also reveal significant familial and friendship connections (Perry et al., 2013; Scott, 2017).

In some instances, anonymization might be essential when publicly disclosing data to protect individuals' privacy or uphold confidentiality in legal matters. This ensures the implementation of privacy-by-design practices to secure data. Beyond privacy concerns, using criminal records and data requires a profound comprehension of individuals' legal statuses. Upholding the presumption of innocence for individuals, whether they are undergoing a judicial trial or not, demands considering the circumstances outlined in the original information source to prevent violating rights to reputation and honor.

Maintaining ethical standards in data science tools is crucial, necessitating the mitigation of risks related to data publication and reuse (Cai and Zhu, 2015; Hosseini et al., 2022). For instance, when governments or powerful entities utilize analytical tools and AI, there's a risk of leveraging their authority to control data repositories. This can lead to witch hunts, prosecution of individuals or judges, or exertion of impunity and political control. Conversely, in ideal governmental practices, intelligence and law enforcement thoroughly investigate network activities with available data, as demonstrated in studies on criminal gangs (Morselli et al., 2007; Papacristos and Smith, 2014; DellaPosta, 2017). However, these analytical tools could be misused by illicit networks or conflicting groups, underscoring the necessity for datasets designed with a "do no harm" principle. Providing data context and specifying the intended usage goals becomes imperative in preventing potential misuse (Letouzé et al., 2013; Pencheva et al., 2018; Wählisch, 2020; Simonofski et al., 2022).

4. The case of Guatemala's CICIG international operation

The establishment of the International Commission against Impunity in Guatemala (CICIG) is intrinsically tied to Guatemala's tumultuous history of over 40 years of internal armed conflict. The aftermath of this complex conflict witnessed numerous efforts to restore peace and disarm groups. However, it also left behind a legacy of predatory military elites with a deep-rooted culture of corruption and a history of exerting control through force (Brands, 2010; Waxenecker, 2019). These elites were entwined with economic and political networks that eroded and applied influence over state institutions, fostering an environment ripe with a wide range of illicit activities (Hudson and Taylor, 2010; Gavigan, 2011; Spector, 2011). Furthermore, illegal security groups and clandestine organizations posed significant threats to human rights through their criminal activities and ability to act with impunity. They undermined the state's capacity to ensure citizen safety, protect human rights, and deliver justice to people (UN, 2006).

The case of Guatemala poses a significant contribution to highlighting the potential of network analysis in conflict. It's a unique scenario where the mandate of the operation specifically aimed to combat corruption and impunity by targeting illicit networks, all while striving for state-building goals. The international mission adopted a strategy involving legal reforms, the replacement of judges, prosecutors, and law enforcement officials with individuals unaffiliated with these illicit networks, and the prosecution of influential figures—politicians, business leaders, political operatives, and gang heads—associated with these networks to dismantle them. However, despite the precision of the mandate's approach, the effectiveness of the tools and strategies employed, as well as the assessment of results, were highly contested due to the resurgence of powerful networks reclaiming control within governmental structures. Moreover, following the closure of the International Commission Against Impunity in Guatemala (CICIG), the examination of networks and contextual findings has revealed insights into the interrelationships among elites, their functions within these networks, and the difficulties encountered in executing prosecution strategies in the absence of network analysis tools. These insights underscore the importance of a data-driven approach in international operations and prompt further discussion on additional challenges emerging after the application of analytical tools in conflict environments.

4.1. CICIG's mandate and efforts targeting illicit elites

In 2003, the State of Guatemala sought assistance from the United Nations, leading to the establishment of the International Commission against Impunity (CICIG) through an Agreement between the United Nations and the State of Guatemala. This agreement was subsequently approved by Guatemala's Congress of the Republic, and the CICIG commenced its operations in 2007 (UN, 2006). At that time, organized crime and cartels had gained effective control over six out of the country's twenty-two states and wielded significant power in three others. Violence was rampant, with murder rates escalating by over 120 percent from 1999 to 2006, marking the highest murder rate in the region spanning from Mexico to Colombia (Brands, 2010, Cruz, 2022). These factors were compounded by insufficient tax revenue, escalating levels of extreme poverty, and growing inequality among the population.

In Guatemala, the peace agreements of 1996 recognized the imperative of rebuilding institutions and ensuring citizen participation. Consequently, the CICIG agreement aimed to strengthen and support the institutions of the Guatemalan state responsible for investigating and prosecuting crimes allegedly committed in connection with the activities of illegal security forces and clandestine security organizations. The CICIG's objectives encompassed identifying the structures, activities, operational methods, and sources of financing of these organizations. It also aimed to facilitate their dismantling and prosecute individuals involved in their activities (UN, 2006).

CICIG had certain powers to carry out its mandate, which included requesting statements, documents, and cooperation from any government official or entity; to investigate any person, official, or private entity, and presenting criminal charges to Guatemala's Public Prosecutor and joining criminal proceedings as a private prosecutor; to report to the relevant administrative authorities the names of civil servants who committed administrative offenses and to participate as a third party in resulting disciplinary proceedings; and finally, recommend public policies and legal and institutional reforms to congress (UN, 2006). Among several other instruments to strengthen CICIG, the government created a special police unit from the National Civilian Police to support the investigations of the Public Prosecutor and created legal obligations for inter-institutional collaboration among financial and oversight agencies by providing information and evidence. In addition, the government of Guatemala committed itself to undertake adequate measures to ensure the protection and security of CICIG officials, the victims, witnesses, and any other person who cooperated with CICIG (UN, 2006).

From the beginning, CICIG was not intended to be a truth commission or the sort to investigate the perpetrators of human rights violations committed during the years of conflict. Its modern mandate was carefully tailored to address the current infiltration of government institutions by clandestine criminal organizations and the operation of illegal security forces (Hudson and Taylor, 2010). Drawing upon criminal insights, CICIG identified the CIACS (later called RPAI) as the root cause of impunity and created a criminal strategy to uncover the networks. It focused on the heads of the criminal gangs and the high-ranked public servants and military forces involved, finding illicit electoral financial structures, administrative corruption, customs fraud, smuggling, narcotraffic, money laundering, and judicial corruption. Within its dismantling approach, CICIG also targeted politicians and businessmen who created shell companies to massively divert public funds through procurement contracts and to hide public money (CICIG, 2019). However, its intelligence capabilities were constrained, and analytical tools, such as network analysis, were underutilized.

4.2. Guatemala's illicit networks: gaining insights with network analysis

This case study offers an opportunity for conducting a historic network analysis due to the abundance of judicialized cases during the tenure of the CICIG. These cases provided detailed information about the individuals' *modus operandi* and interrelations. A pivotal factor contributing to the substantial judicialization of criminal offenses was the work of the independent prosecutor of the CICIG, which facilitated evidence collection, categorization of criminal activities, and the pursuit of victim reparation in courts (Zamudio-González, 2021). In terms of network analysis, the CICIG provided relational data and activity reports from these cases. Physical evidence in corruption cases was obtained through contracts, negotiable

instruments, bank transfer reports, and communications acquired through judicial orders, among other sources, to unveil falsifications or simulations of operations (CICIG, 2019).

Waxenecker's (2019) comprehensive network analysis, augmented by contextual insights, entailed building a dataset that interlinked individuals, businesses, and institutions. This dataset depicted a complex network of social connections and legal proceedings leading to convictions spanning from 2011 to 2015. This network was built upon eight key cases: 1) The Line; 2) Impunity Law Firm; 3) Former Deputy Gudy Rivera; 4) The Coperacha; 5) Co-optation of the State; 6) TCQ; 7) Land Information Registry: a payment box; and 8) Case of Subordination of the Legislative Power to the Executive (Waxenecker, 2019). The dataset included over 300 individuals, government agencies, public officials, and business associations related to each case.

The primary finding of the network analysis modeling revealed that individuals and institutions involved in the eight cases formed a cohesive and interconnected large component within a bipartite network. The aim was to identify connections and weights within the network, highlighting individuals with high levels of connectivity to others. This network model represents the relational dynamics of power particularly during the electoral campaign and the exercise of government power by the "Patriotic Party". The analysis of criminal investigations within this network identified key central nodes referred to as "core powers", including former President Otto Pérez Molina, former Vice President Roxana Baldetti, and former Secretary of the President Juan Carlos Monzón. The network analysis utilized degree and intermediation indicators to explain the concentration of power. Notably, the ministers of government, defense, communications, energy, mines, and the Social Security Institute played pivotal roles in the connectivity of network components, particularly in the Coperacha case, which involved exchanges of gifts between public servants and the President (Waxenecker, 2019).

According to the case contextual investigation, the central powers (former president, ministers, individuals involved in criminal activities, and military personnel) acted through the political party "Partido Patriota" to appoint high-ranking public officials. This allowed for the diversion of public funds to enrich an elite group and establish enduring effective clusters that maintained control over procurement markets, regardless of changes in political leadership (CICIG, 2019; Waxenecker, 2019).

The second significant discovery pertains to the distribution of illicit activities within the network. By observing individuals and their actions, the analysis revealed that criminal gangs and covert military units were utilized to expand the network's scope. These entities engaged in extrajudicial executions, human trafficking, drug trade, illicit trafficking of goods and people, and extortion (CICIG, 2019). Further research indicates that the network exploited judicial channels by leveraging judges to grant immunity to its members, while judicial candidates secured positions through favoritism, privilege, and undue influence (CICIG, 2019, Escobar, 2019; Waxenecker, 2019).

Thirdly, the analysis exposed an extensive web of businesses contracted by the government and the central power. These enterprises acted as intermediaries in specific sectors like construction, security, and port control. Key figures within these businesses were implicated in crimes such as fraud, bribery, illegal wealth accumulation, and the perpetuation of undue influence. Their economic and political clout, coupled with their close ties to the central power, allowed them to exploit mechanisms for illicit enrichment and operate with impunity (Waxenecker, 2019).

Finally, the analysis illuminated the pivotal roles and influence of military actors throughout the network's operations. Both inside and outside formal institutional frameworks, these individuals wield substantial power within the network's vertical and compartmentalized structure. They maintained interconnectedness with a political system heavily influenced and infiltrated by criminal and drug trafficking networks. The network exhibited a central position in political-strategic coordination and demonstrated cohesive operations within an organized framework (Waxenecker, 2019).

While Waxenecker's network analysis is confined to national networks due to the cases data used, it's crucial to note that Guatemala's criminal networks primarily operated transnationally, exhibiting intricate structures across diversified illicit markets. These networks maintained connections with international drug trafficking organizations like the Zetas and Sinaloa Mexican Cartels, engaging in a spectrum of illicit activities. With substantial financial resources, they directly funded political parties, presidential

campaigns, and congressional endeavors (Brands, 2010; Gavigan, 2011; Waxenecker, 2019). Another influential group known as the '*poderes ocultos*' or hidden powers comprised individuals leveraging their positions and connections across public and private sectors (Mattiache and Pappier, 2022). Moreover, street gangs like the Maras, extending their reach into other Central American countries, were involved in extortion, robbery, small-scale drug trafficking, homicides, and abductions (Brands, 2010; Cruz, 2022).

4.3. Discussing CICIG's impact in dismantling illicit networks

In 2019, Guatemala's decision not to renew the United Nations agreement marked the conclusion of CICIG, terminating its operations shortly after launching an investigation into economic crimes implicating President Jimmy Morales' family, alongside military officials and politicians tied to past war crimes (WOLA, 2022). Subsequently, influential figures linked to existing illicit networks exposed by CICIG assumed control of the government and the Attorney General's office. Their actions targeted journalists, civil society leaders, judges, and public servants involved in prosecuting individuals within these networks. This upheaval forced judges and former prosecutors to flee, while others faced unjust imprisonment on fabricated charges (IACHR, 2021; Mattiache and Pappier, 2022; WOLA, 2022). Paradoxically, key figures from these networks were absolved of charges.

The anti-corruption accords in Guatemala represented a pivotal moment in the nation's history of international agreements. Nevertheless, CICIG's approach, while occasionally effective in judicial proceedings (Call and Hallock, 2020), primarily relied on criminal prosecutions and legal reforms to dismantle illicit networks. This strategy exposed the power structures within Guatemala, shedding light on the dynamics between the military, public sectors, courts, congress, political parties, and organized crime (Beltrán, 2020; Call, 2021). Collaborating with the attorney general's office, CICIG achieved an impressive 85 percent efficiency in charging and convicting over 400 individuals and entities (CICIG, 2019; WOLA, 2022).

However, while this punitive strategy might have weakened the networks' economic and political influence for some time, the lack of robust analytical tools made it challenging to gauge its long-term impact and the imbalances generated within these intricately interconnected networks. Attempting to prosecute the numerous defendants from the networks overwhelmed the judicial system and penitentiary institutions, leading to case dismissals and burdening judges (Zamora Palma, 2023). Consequently, crucial aspects like enhancing judicial independence, building institutional capacities, enforcing economic sanctions, and recovering illicit assets might have been sidelined. Moreover, the abrupt termination of the agreement and the expulsion of trained officers hindered the transfer of critical knowledge, as CICIG was designed for state-building rather than permanent intervention (Simon, 2023).

The initial UN-Guatemala agreement establishing CICIG recommended preventive measures against the resurgence of illicit networks. Employing network analysis could have been instrumental in pinpointing specific syndicates and tailoring measures based on individual roles and influences within these networks. This involved leveraging insights from network analysis to explore alternative strategies, like encapsulating groups rather than relying solely on a kingpin strategy (Contreras Velasco, 2023), identifying ways to weaken the network's workforce (Prieto-Curiel et al., 2023), and supplementing punitive measures with social and formal economic reintegration of individuals (da Cunha and Gonçalves, 2018). Furthermore, proactive strategies could have been developed to shift CICIG's functions to other institutions after its mandate expired, promoting accountability and enhancing analytical capabilities within Guatemala's anti-corruption alliances. This approach could have anticipated conflicts and effectively disrupted the structure and activities of corrupt networks, thereby controlling the impact of their potential resurgence.

Ultimately, the lessons learned from this case underscore the potential value of employing network analytics in international missions combating illicit networks and implementing state-building strategies, both pre- and post-intervention.

5. Final remarks and further research

International peace and state-building operations face the imperative need for innovative strategies to bolster their effectiveness. Specifically, a meticulous reevaluation becomes essential when these operations involve objectives encompassing both the dismantling of networks and the reconstruction of state institutions, all the while empowering media and civil society (Gavigan, 2011; Salazar, 2019; Simon, 2023).

Conventional definitions often fall short in capturing the intricate dynamics present in conflict zones (Philip, 2012; Andersen, 2016), thereby impeding the efficacy of interventions, agreements, and overall operations. In response to this challenge, this article advocates for operational mandates that embrace a complexity framework, providing a nuanced understanding of the multifaceted nature inherent in targeting networks. Aligning such frameworks with analytical tools is crucial for projecting outcome-oriented goals more effectively.

A pertinent example is illustrated in the case of CICIG, where a lack of a data-driven approach even before intervention significantly influences the targeted strategy. This deficiency not only impacts the identification of effective punishment interventions but also hampers the monitoring of progress and forecasting of success probabilities. Moreover, it impedes the anticipation of potential obstacles and unintended consequences, such as the resurgence of illicit powers. Therefore, it is imperative to analyze the evolving behavioral patterns and structural features within these networks. This analytical approach is vital for implementing effective preventive measures (Perry et al., 2013), developing assessment metrics, and making informed, data-driven decisions to control and guide interventions. By adopting this comprehensive approach, international peace and state-building operations can enhance their capacity to navigate complex environments and achieve more successful and sustainable outcomes.

While network analysis offers considerable insights, relying solely on it can be misleading and prone to policy and prediction errors (Ward et al., 2010). International interventions, wielding substantial political influence, often perpetuate power imbalances and reinforce both legal and illegal networks entrenched in historical conflicts or existing business ties. In certain scenarios, these interventions may even worsen crises and heighten the probability of conflict escalation (Lindley, 2007). This article stresses the crucial role of analytics in assessing risks within each descriptive framework, notwithstanding its limitations. This approach ensures that insights gleaned are translated into practical implications with direct relevance to real-life situations. Successful application necessitates a collaborative, multidisciplinary approach involving diverse stakeholders—government officials, civil society organizations, media, journalists, and international partners—to craft nuanced responses to the multifaceted challenges within conflict zones. The emphasis lies in steering clear of unrealistic or purely theoretical outcomes (Perry et al., 2013; Gnanguenon, 2021).

Acknowledging the complexities surrounding governments' adoption of analytics, particularly in conflict and post-conflict nations where understanding of powerful illicit networks is often scant, this article recognizes the obstacles. These countries are frequently governed and manipulated by such networks, hindering institutional and judicial improvements (Andersen, 2016). Overcoming these hurdles necessitates significant organizational transformation, including the development of technical infrastructure, investment in analytics tools and robust data management systems for big data, and the establishment of specialized data scientist units within intelligence agencies (Pencheva et al., 2018). Additionally, challenges arise from differing levels of technological adoption, ethical concerns regarding tolerated practices, privacy concerns, and objections to certain governmental behaviors (Pencheva et al., 2018).

Future research should delve into how a tailored approach can enhance the precision and relevance of interventions, sidestepping potential pitfalls linked to overly abstract or idealistic outcomes. Moreover, while network analysis is powerful, its limitations are evident in conflicts like Guatemala's, where external groups may fuel violence beyond the scope of predictive tools. To counter this, raising regional and continental alerts through collaborative frameworks becomes imperative (Gnanguenon, 2021). It's crucial to supplement descriptive and predictive analysis with other methods for detecting conflict, violence, and corruption—a multi-method approach for crisis forecasting (O'Brien, 2010). Furthering

scientific research that bridges the gap between predictive tool findings and policymakers' decision-making processes is pivotal (Masys, 2014; Gnanguenon, 2021).

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