Towards an understanding of illegal supply chain design in conflict areas: the case of the grain supply chain in Ukraine

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Abstract

Purpose: The purpose of this research is to shed light on illegal supply chains (ISCs) and the factors (enablers) behind their emergence using data on grain supply chain in Ukraine.

Design/Methodology: A two-step methodology was adopted. First, documentary sources (including press articles, published papers, reports, and grey literature) on grain ISCs in Ukraine were analysed using the Fraud Diamond theory with the aim of identifying the main underlying issues. Second, interviews with experts were conducted to elaborate on the propositions regarding ISC design and enablers.

Findings: The findings revealed the existence of two ISCs in Ukraine: the fraudulent grain and looted-grain supply chains (SCs). We propose an integrative ISC framework based on a combination of Fraud Diamond theory components (pressure, opportunity, rationalisation, and capability) and SC network design elements (formalisation, centralisation, complexity, and density). We suggest that ISCs in conflict regions emerge owing to geopolitical instability and lack of logistics optimisation and provide several propositions for further research.

Research Limitations/Implications: This research contributes to the literature on ISCs by offering nuanced understanding of their design and enablers. It underscores the impact of geopolitical disruptions on ISC operations and highlights how factors such as logistical inefficiencies, bottlenecks, and infrastructural weaknesses facilitate the activities of these illicit networks. This study provides valuable insights beyond the context of the Russia-Ukraine conflict, offering broader applicability to other scenarios, where disruptions - whether geopolitical, economic, or environmental – expose SC vulnerabilities.

Practical Implications: The results of this study can be informative for government authorities and policymakers in formulating measures aimed at addressing illegality in SCs.

Originality/Value: This study is the first to investigate ISCs in conflict areas by analysing the case of the grain SC in Ukraine. This study provides a solid foundation for future research on ISCs with similar characteristics.

Keywords: Illegal supply chains, Supply chain design, Conflict region, Fraud Diamond theory, Geopolitical disruptions, Criminal supply chain practices

Paper Type: Research paper

1. Introduction

Studies on criminality and the illegal and ethical practices in the supply chain management (SCM) field have become a prolific stream of research. The complexity of supply chains (SCs) coupled with globalisation has provided fertile grounds for the emergence of illegal and unethical behaviours. Researchers have become increasingly interested in expanding the scope of their research to include aspects related to legal and political issues, including illegal and fraudulent SCs (Zhang *et al*., 2022; Liu, 2022; McElwee *et al*., 2017). Illegal supply chains (ISCs) are those involved in activities that violate national laws or international obligations and range from misconduct, corruption, and exploitation to plain criminal activities (Pullman *et al*., 2024). Despite the increasing academic interest in ISCs, new studies on this topic are still emerging (DuHadway *et al*., 2022). Research on ISCs can benefit from recent calls from several scholars to adopt a sociopolitical perspective that emphasises the complex interplay between economic forces, political policies, and social structures (Bednarski *et al*., 2024; Roscoe *et al*., 2022). Such a sociopolitical perspective considers the SC as a complex social–ecological system (Wieland, 2021) in which social and geopolitical issues are prominent (Roscoe *et al*., 2022; Bednarski *et al*., 2023; Srai *et al*., 2023).

Several studies on ISC structure and design were conducted with the underlying assumption that ISCs are similar to legal SCs at the operational level because their activities entail planning, sourcing, manufacturing, and delivery processes (McElwee et al., 2017; Pullman *et al*., 2024; DuHadway *et al*., 2022; Fox *et al*., 2018). However, most research on ISCs can be considered one-dimensional, with a fragmented approach to understanding how such networks are structured. For instance, some studies have examined ISC business models based on the criminality dimension (McElwee et al., 2017; Smith and McElwee, 2021; Smith et al., 2017) or analysed the ISC structure from a focal firm perspective (DuHadway et al., 2022). How ISCs emerge and structure their activities in the aftermath of geopolitical disruption remains an under investigated topic despite the potential theoretical and empirical contributions that would result from the integration of the sociopolitical approach to SCs. To better understand the ISC phenomenon, an assessment of how the enablers of illegal practices (factors that trigger illegal activities in SCs) can affect or interact with the structure of an ISC is essential; however, few studies have been dedicated to this effort.

The current volatile geopolitical context provides an appropriate setting for enhancing our understanding of ISC operations and structures to identify the main enablers of such illegal practices. Research highlighting how the context of geopolitical disruptions, accentuated by the

outbreak of armed conflict, affects the emergence of ISCs has become paramount for researchers and practitioners interested in investigating the modus operandi of criminal networks.

The Ukraine-Russia war represents an appropriate context for SC researchers to investigate ISCs in conflict regions. Russia invaded Ukraine in February 2022, and the ensuing war generated negative impacts through the disruption of oil, gas, and grain SCs (Tollefson, 2022). In particular, armed conflict has become suitable grounds for many illegal activities that affect already vulnerable grain SCs (Ali and Govindan, 2021). News reports have revealed that several thousand tonnes of cereals were smuggled into the Black Sea countries during the war (Financial Times, 2022), making the grain SC a suitable case study for ISC practices. Understanding how ISCs evolve requires exploring how such networks are structured and identifying the organisations and individuals participating in such practices. Such an endeavour is needed because there is a dearth of research on how an SC structure might trigger, facilitate or hinder illegal activities (Smith and McElwee, 2021; Pullman *et al*., 2024). Furthermore, the causes of the emergence of ISCs is at the centre of research (Pullman *et al*., 2024). Understanding the factors (enablers) behind ISC behaviour–that is, causes and mechanisms–is a prerequisite for the development of policies to combat illegality. ISCs are not stimulated merely by profit and gain, but often necessitate other drivers (Pullman *et al*., 2024). Further research is needed to examine the motivations behind illegal practices which can shed light on the opportunities, capabilities, and incentives that stimulate ISCs. Therefore, we provide a theoretical perspective for mobilising both ISCs designs and their enablers to understand this phenomenon.

Consequently, we investigated the following research questions:

RQ1: What are the factors (enablers) behind the illegal practices adopted by the Ukrainian grain SC?

RQ2: How do these enablers affect the structure (design) of illegal grain SCs in Ukraine?

Drawing on the Fraud Diamond theory, we present the design of ISCs as influenced by four components: opportunity, incentive, rationalisation, and capability (Rustiarini *et al*., 2019). The Fraud Diamond theory belongs to legal theories that have often been mobilised to conceptualise the illegal activities of individuals and/or organisations (Dorminey *et al*., 2010). We combine the Fraud Diamond framework with an exploration of ISC characteristics using SC design principles from established SCM literature (Chopra and Meindl, 2019; Roscoe *et al*., 2022). In our research, we used data from academic research, investigative journalism, interviews with geopolitical and SC experts, documentary research, official reports, and newspaper articles

following previous research on criminals and ISCs (McElwee *et al*., 2017; Valk *et al*., 2020). The data available in the press were reviewed, and interviews with SC and geopolitical experts were conducted in this study.

The aim of this study was to develop a theoretical model of ISC design to contribute to the research. First, we answer the call for more research on ISCs and fraud in SCs (Pullman *et al*., 2024; DuHadway *et al*., 2022) to provide a better understanding of the 'what', 'how', and 'why' of this phenomenon. We propose the integration of the Fraud Diamond and SC design theories to shed light on the emergence and evolution of ISCs. Our research attempts to extend SC knowledge to the illegal domain by mobilising elements related to SC design, logistics, criminology, and policy literature. Second, we theorise ISC enablers from the perspective of Fraud Diamond theory to explain how such networks thrive in conflict regions. Therefore, the framework that we propose complements prior research on the influence of the political environment on SC strategy by proposing the use of legal theory in an alternative setting (i.e. conflict ISCs). Our research is in line with recent efforts to integrate the sociopolitical perspective into SCM research and the effects of geopolitical disruptions on SCs (e.g. Srai *et al*., 2023; Roscoe *et al*., 2022; Sheth and Uslay, 2023). Third, we identify two main ISCs: looted and fraudulent grain SCs. We present the activities and actors involved in ISCs to explain how they structure their networks and attempt to avoid sanctions. Our analysis of ISCs through the lens of the Fraud Diamond and SC design theories provides insights applicable to various high-risk SCs beyond the Ukraine-Russia conflict. For instance, our findings can be used for comparison with other conflict-affected areas such as conflict mineral SCs (Zhang *et al*., 2023). Furthermore, the study's exploration of contextual vulnerabilities-such as logistical inefficiencies and systemic disruptions-provides a comprehensive framework for understanding the dynamics of ISCs during crises, whether driven by geopolitical, economic, or environmental factors. By focusing on universal mechanism and structural factors that underpin ISCs, this research ensures its theoretical contributions remain relevant across different contexts.

Finally, this study sheds light on ISCs in conflict regions which may be useful for public policy scholars and SC practitioners seeking to mitigate the effects of ISCs and/or enhance the visibility and transparency of operations. Policymakers and decision makers may find our research informative regarding how SC aspects explain illegal and criminal activities (Pullman *et al*., 2024). Generating a better understanding of ISC design and enablers can help develop more efficient and effective measures aimed at combatting illicit and criminal activities. The remainder of this paper is organised as follows. The theoretical background and framework are presented in Section 2. Section 3 is dedicated to the data-gathering process from documentary

sources and interviews with experts who were instrumental in developing our interdisciplinary framework of ISC design and enablers. Several propositions are suggested and discussed before concluding by synthesising the implications stemming from this research as well as prospective avenues of research.

2. Understanding ISC practices: A theoretical background

Research on the intersection of criminality, unethical practices, and ISCs in the field of SCM has gained increasing attention. Several terms have been employed in the literature to describe criminal activities in SCM, including fraud (DuHadway *et al*., 2022), counterfeiting (Handfield and Nair, 2019), misconduct (Skilton and Bernardes, 2022), and corruption (Carter, 2000a). Each term captures a unique aspect of the challenges that both legal and ISCs present, and scholars recognise that illicit supply chains often mirror legitimate ones operating within the same ecosystem but for antagonistic purposes (Smith and McElwee, 2021; McElwee *et al*., 2017). The coexistence of legal and ISCs creates significant challenges in managing operations, as these parallel systems are interconnected through antagonistic gateways (Smith and McElwee, 2021). These gateways represent points at which legitimate and illicit activities converge, often through intermediaries that facilitate the movement of goods or information between the two systems. The literature highlights various factors that enable criminality in SCs, such as market conditions, institutional environments, and personal motivation (Oglethorpe and Heron, 2013). These factors suggest that the structure and regulatory framework of an SC can mitigate or exacerbate illegal activities.

2.1 Unravelling the complexity of ISCs

Several studies have explored the relationship between the SC structure and its exposure to criminal activities. As SCs become longer and more intricate, their vulnerability to criminal exploitation increases (Asbjørnslett, 2009). This is particularly true in global SCs where cross-border operations and multi-tiered supplier networks complicate oversight and create opportunities for illicit behaviour (Arnold *et al*., 2012). Factors such as organisational complexity, corporate culture, and international operations have been identified as key contributors to a firm's susceptibility to corruption and misconduct in SC operations. For example, trust between SC partners is essential for effective collaboration; however, it can also become a source of vulnerability. DuHadway *et al*. (2020) argued that a combination of formal controls and relational governance is necessary to reduce opportunism in SC relationships. Yazid *et al*. (2020) identified several fraud risk factors, such as pressure, opportunity, and auditor capability, which can influence the likelihood of fraud within SCs. These insights are critical for understanding how the different facets of SCM can be leveraged to prevent or

facilitate illicit activity. One notable distinction in this discourse is unethical and illegal practices. While illegal activities are defined as explicit violations of laws and regulations, unethical practices often exploit regulatory loopholes or the absence of legal constraints (Freeman, 1984; Fassin, 2005). This distinction is important for understanding the grey areas in SCM, where legal but unethical actions such as exploiting labour standards in developing countries can lead to significant reputational and operational risks. Pullman *et al*. (2024) categorise SC operations into three types based on their degree of legality: (i) fully illegal operations, (ii) partly illegal operations, and (iii) grey market SCs where operations are legal in one jurisdiction but illegal in another. This classification highlights the need for a nuanced approach to understanding criminality in SCs.

2.2 Conceptual models for analysing fraud and ISCs

To better conceptualise how criminality and unethical behaviour manifest in the SC, two theoretical frameworks are particularly relevant: the Fraud Diamond framework and the SC network design framework. These frameworks provide complementary lenses through which to analyse the conditions that give rise to ISCs.

2.2.1. Fraud Diamond framework

The Fraud Diamond framework (Wolfe and Hermanson, 2004), an extension of the Fraud Triangle theory (Cressey, 1953), is central to understanding how fraud occurs in both individual and organisational contexts. The Fraud Diamond identifies four key elements that contribute to the occurrence of fraud. First, pressure refers to the motivation driving individuals or organisations to commit fraud, which can be financial, such as the need to satisfy revenue targets, or non-financial, such as the desire for status or power (Albrecht *et al*., 2015). Second, opportunity arises when the perpetrator identifies a chance to commit fraud, typically facilitated by weak internal controls, a lack of oversight, or an organisational culture that tolerates unethical behaviour (Dorminey *et al*., 2012; Schuchter and Levi, 2015). Third, rationalisation is the process by which individuals involved in fraud justify their actions as morally acceptable, allowing them to maintain a positive self-image despite their involvement in illegal activities (Rustiarini *et al*., 2019). Finally, capability represents the ability to commit fraud, which depends on an individual's skills, position within the organisation, and capacity to influence others or circumvent control mechanisms (Dellaportas, 2013).

The Fraud Diamond framework is particularly useful in the SC context because it can explain not only individual fraud but also systemic fraud within organisations and across SCs. Its holistic view, which incorporates both personal and structural factors, makes it ideal for analysing the interplay between opportunity and organisational complexity in ISCs.

2.2.2. SC network design framework

SCs can be understood through the lens of network design theory. A SC network consists of a system of interconnected firms that collaborate to produce and distribute goods (Ketchen Jr and Hult, 2007). SCs are typically organized around a focal firm that coordinates activities with a network of suppliers, manufacturers, and distributors (Borgatti and Li, 2009). Several network structure dimensions are particularly relevant for understanding criminality in SCs. Firstly, formalization, which refers to the extent to which formal rules and procedures govern SC operations, can reduce the likelihood of criminal activity by ensuring greater consistency and accountability across networks (Choi and Hong, 2002). Secondly, centralization, defined as the degree to which decision-making authority is concentrated in the hands of a few actors within the SC, may make SCs more resistant to certain types of fraud but can also render them more rigid and less adaptable to changes (Kim *et al*., 2011). Thirdly, network density, which measures the number and strength of connections among SC members, can enhance efficiency but also create opportunities for collusion and other forms of misconduct (Bellamy *et al*., 2014). Lastly, complexity, which increases with the diversity and geographical dispersion of an SC, complicates monitoring and regulation, thereby providing opportunities for bad actors to exploit the system for illicit activities (Choi and Hong, 2002; Gao *et al*., 2015).

By applying the SC network design framework to ISCs, we can better understand how structural characteristics such as formalisation and complexity influence the likelihood of illegal activities occurring within the SC.

2.3 Research gaps in existing literature

Despite the growing body of research on ISCs, a significant gap remains in the literature that needs to be addressed to fully understand how criminal activities emerge and flourish within SC networks. The following gaps are particularly evident when examining the application of fraud-related and SC network theories to the organisational and structural dynamics of ISCs.

Research gap 1: Limited application of the Fraud Diamond framework at an organisational level

The Fraud Diamond theory, while frequently mobilized at the individual level (Wolfe and Hermanson, 2004), has been underutilized in the context of organizational-level fraud and group dynamics within SCs. Existing research has largely focused on individual actors, such as employees or managers who engage in fraudulent activities driven by personal motivation, opportunity, rationalisation, and capability (Dorminey *et al*., 2010). However, SCs involve multiple organisations collaborating across complex networks where fraud may emerge from collective actions, organisational cultures, and interfirm relationships (Schuchter and Levi,

2015). By applying the Fraud Diamond framework at the organisational level, this study seeks to bridge this gap by exploring how group pressure, interorganisational opportunities, and firm-level rationalisations contribute to the prevalence of fraud within SCs. A systemic understanding of fraud, recognising it as an issue not only for individual actors but also for organisational structures, can provide deeper insights into how ISCs operate. This is particularly crucial in environments with fragmented compliance mechanisms and weak regulatory oversight (Rustiarini *et al*. 2019).

Research gap 2: Lack of integration between fraud and SC structure theories

Another significant gap is the lack of integration between fraud-related theories (such as Fraud Triangle and Fraud Diamond) and those focusing on the structural design of SC networks. While fraud theories explain individual- and organisational-level motivations and opportunities for misconduct, SC network theories address the structural properties of supply chains, such as formalisation, centralisation, and network complexity, which create environments susceptible to exploitation (Choi and Hong, 2002; Kim *et al*., 2011). For instance, highly formalised SCs with clear governance and standardised procedures are less prone to fraud owing to their stringent oversight (Gibson *et al*., 1997). However, decentralised networks lacking cohesive decision-making or effective monitoring mechanisms are more vulnerable to exploitation (Bellamy *et al*., 2014). The separation between organisational motivations for fraud and the structural vulnerabilities has not been fully bridged in the literature. This gap is significant because the interaction between structure and fraud-enabling conditions remains underexplored. The structural characteristics of SCs, such as network density and spatial complexity, can either mitigate or exacerbate opportunities for fraud, particularly in global networks where multi-tiered suppliers operate with varying levels of oversight (Cheng and Shiu, 2020). Addressing this gap will enable the development of a more integrated analytical framework that combines fraud and network structure insights to analyse ISCs more holistically.

Research gap 3: Underexplored context of high-risk and conflict-prone regions

A third critical gap concerns the application of these frameworks to high-risk environments, such as conflict-prone regions or politically unstable countries where supply chains are more vulnerable to illicit activities. Much of the existing ISC research focuses on developed economies with robust regulatory frameworks (Pullman *et al*., 2024). However, SCs in emerging economies, particularly in conflict zones or regions with weak institutional frameworks, are often more susceptible to fraud because of limited governance and fragmented enforcement mechanisms (Arnold *et al*., 2012). This gap is particularly relevant in the

Ukrainian grain industry, where geopolitical instability increases the risk of fraudulent activities within SCs. In such environments, traditional fraud drivers identified by the Fraud Diamond framework, such as pressure, opportunity, rationalisation, and capability, may manifest differently (Yazid *et al*., 2020). For example, political instability, disruption of SC oversight, and informal governance structures may create unique opportunities for fraud that are not adequately captured by current theoretical frameworks. By focusing on high-risk regions, this study extends the applicability of these frameworks to largely overlooked contexts. This is crucial for understanding the global dynamics of illicit SCs, particularly in conflict-prone or weakly regulated regions and for developing context-specific strategies to combat fraud and corruption (Oglethorpe and Heron, 2013).

This study seeks to fill these gaps by applying the Fraud Diamond theory at the organizational level to assess how group dynamics contribute to the emergence of ISCs, and by utilizing the SC network design theory to examine how SC's structure influences the development of illicit activities. By doing so, this research provides new insights into the organizational and structural drivers of criminality in SCs, with a particular focus on the grain SC in Ukraine.

3. Methodology

Illegal activities are mostly covert. Therefore, direct access to relevant key informants to assess how they plan, design, and commit illegal behaviour is difficult (Duensing *et al*., 2023). Secondary data sources have been explored in several previous studies on fraud and illegal and unethical practices in SCs (e.g. Smith *et al*., 2017; Smith and McElwee, 2021). A two-step methodology was adopted in this study: immersion and narrative enquiry of data (Section 3.1), followed by semi-structured interviews with carefully chosen geopolitical and SC experts (Section 3.2).

3.1. Immersion and narrative inquiry process

First, we followed Scott (2014) and relied on documentary sources related to grain ISCs (mainly press and academic articles) as well as grey literature publications (reports, articles, papers, and internet blogs). The relevant material was assembled through *immersion* (Borkan, 1999; Ellingson, 2009). Immersion is a process that allows high levels of knowledge to be acquired by submerging collected data; that is, experiencing, reading, and assessing portions of the information in great detail. Subsequently, the data gathered through the immersion process were authenticated using *narrative inquiry* techniques (Smith and McElwee, 2021; Hunter *et al*., 2014). Narrative enquiry is the recursive and reflexive process of moving from documentary

evidence through the narration of a living story (field text) to interim and final research texts. We collected, reviewed, and elaborated on a database of grain SC in Ukraine in a master file. Next, a case story (Yin, 2014) was written up, laying down a narrative order of events surrounding the effects of the war in Ukraine on grain SCs. Data gathered from media reports and newspaper articles were summarised to present a coherent continuing story that underlines the chronology of events and development of ISCs.

The main documentary sources of this research consist of the following:

(i) Press agency reports and releases: Reuters, AP, Financial Times, The Guardian, The Economist, The New York Times, Bloomberg, and others,

(ii) Academic publications in peer-reviewed journals and grey literature,

(iii) Think tank Internet blogs and reports such as the World Policy Conference, the Chatham House, the Council on Foreign Relations and the Atlantic Council,

(iv) NGO reports from the Organized Crime and Reporting Project (OCRP) and Global Rights Compliance's (GRC) Starvation Mobile Justice Team, and

(v) Official reports and statistics of the United Nations Food and Agricultural Organization (FAO), The World Bank, The International Grains Council and the Ukrainian Grain Association (UGA).

Focusing, refocusing, reviewing and regrouping information allowed us to synthesise the data and 'see connections' across and between events in the Russia–Ukraine conflict and grain SCs. The chronology of events helped us understand the data and uncover the structure and enablers of ISCs. Based on the above sources, we were able to: (i) present a timeline of the main events related to grain SC operations, (ii) present an outline of 'legal' grain SC activities, and (iii) describe the 'illegal' grain SCs.

3.2. Design of the qualitative interviews with experts

Studies on criminals and ISCs often use interviews with experts to reinforce the validity of the gathered data (Smith and McElwee, 2021; Smith *et al*., 2017). Based on several studies employing interviews with experts (von der Gracht and Darkow, 2010; Reefke and Sundaram, 2018; Singh and Gupta, 2019), the selection of interviewees was based on objective criteria that ensured they had adequate knowledge and expertise on the phenomenon under investigation. Additionally, it was preferable to have experts from various backgrounds with diverse opinions (Rowe *et al*., 1991) and to obtain pertinent perspectives (von der Gracht and Darkow, 2010). Consequently, we selected experts with professional and/or academic backgrounds who demonstrated their knowledge of grain SCs, ISCs, and geopolitical issues related to conflict regions in general and particularly to the war in Ukraine. Fifteen experts were approached for

this study, and nine agreed to participate. The number of experts satisfied the recommendations of numerous scholars who have deployed similar approaches in their studies (Singh and Gupta, 2019; Reefke and Sundaram, 2018); that is, from five to a maximum of 50 experts.

Table 1 Experts' characteristics

Expert	Background	Position	Experience	Country	Familiarity with grain SCs and ISCs in conflict regions
Expert 1	Geopolitics, History and Politics of the International System	Professor of History and Politics of the International System	20 years	Italy	Conducted research on socioeconomics and geopolitics in Eastern Europe
Expert 2	Political Philosophy, strategy and geopolitics	Professor of Political Philosophy and Political Science	11 years	Italy	Conducted research on ethics of economic globalisation
Expert 3	Ph.D. in Political Sciences	Senior lecturer in international relations and politics	7 years	France	Expertise related to illegal and illicit trade in several regions (Middle-East with a focus on Turkey and Syria, and South America).
Expert 4	International and political occupations and consultancy in international affairs	Senior consultant in geopolitics and international affairs	23 years	U.K.	Advisor and consultant for governments, international embassy missions, and business development.
Expert 5	Logistics, shipping	CEO of a logistics services provider (LSP) company	20 years	France	Expertise in grain shipping for clients in Africa and Asia.
Expert 6	Logistics, SCM	Consultant and senior executive of a fourth-party logistics (4PL) firm	15 years	Belgium, Germany	Expertise in importing and shipping grain for several African, Middle East, and Asian companies.
Expert 7	Political science, sociology and international affairs	Geopolitical expert and senior lecturer	30 years	Ukraine	Professor of international relations and political science with a focus on Ukraine's geopolitical issues.
Expert 8	Strategic studies and law	Writer and consultant	12 years	France	Expertise in geopolitical risks in areas of conflict.
Expert 9	Logistics, freight, transport	Transport manager in logistics service provider (LSP) firm	15 years	Italy	Experience in importing grain from Eastern Europe.

Source: Authors

Interviews were conducted in February 2024 either online (using video calls) or face-to-face with experts. The interviews were conducted using a semi-structured interview guide comprising open-ended questions and propositions stemming from documentary sources based

on our narrative enquiry. Yin (2014) indicated that a good interview protocol reduces the bias caused by different interviewers and respondents and assists respondents in the rational development of suitable procedures for answering questions. The semi-structured interview guide was pre-tested and validated by five scholars in the fields of SCM and geopolitical studies to enhance the clarity and relevance of the questions. The final version of the interview guide consists of four sections: (1) demographic information, (2) characterisation of illegal grain SC(s) in Ukraine, (3) illegal grain SC design and structure, and (4) the factors/enablers of ISCs based on the Fraud Diamond theory (Appendix 1). The interview duration ranged from 1.5 to 2 hours. We discussed with the experts the main propositions related to ISC design and the Fraud Diamond framework, thus facilitating the content analysis of the interviews (Easterby-Smith *et al*., 2012). The interview transcripts were shared with experts to validate their content and matched to secondary data sources and narrative enquiry information to enhance the presentation of the results (Yin, 2014).

4. Findings

4.1. Timeline of events related to grain SCs in Ukraine

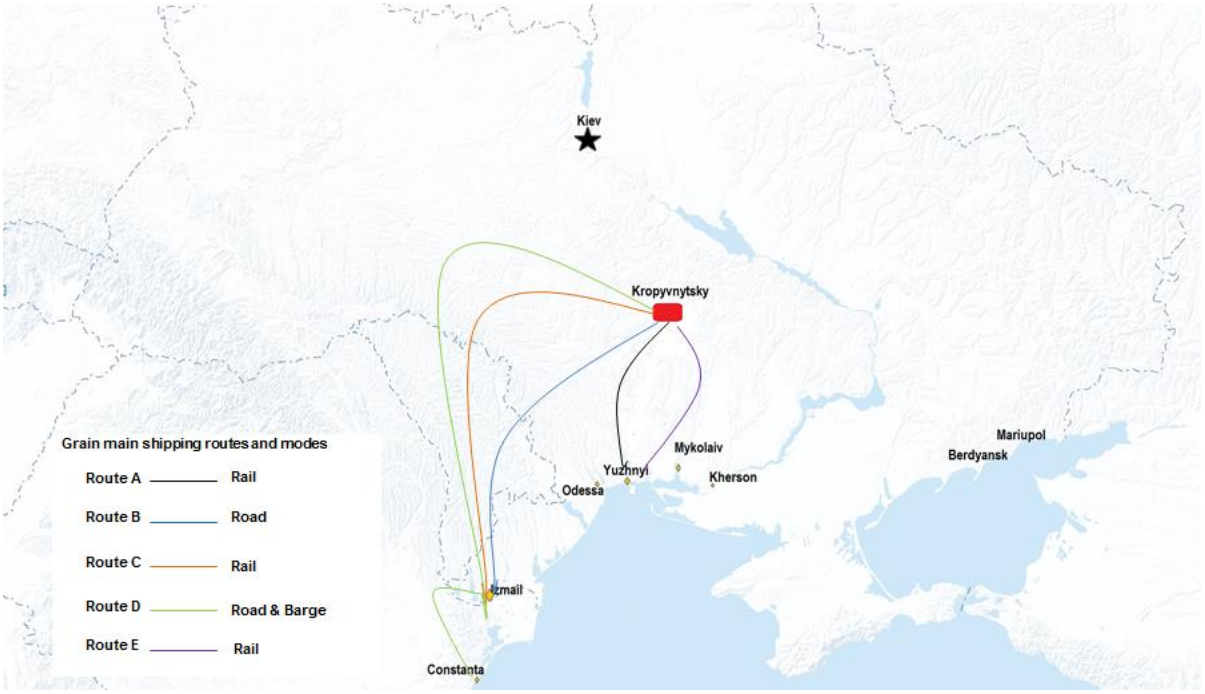
Russia and Ukraine are the world's largest suppliers of grain, with Russia exporting 20% and Ukraine 10% of the global grain exports (Gay *et al*., 2022; Chatham House, 2024). The war started on the February 24, 2022, when Russia decided to launch a "special military operation" in Ukraine. Since then, the ongoing military conflict has damaged the inland transport and seaport infrastructure in Ukraine (Kuts and Makarchuk, 2022; Fernandes *et al*., 2023) creating a global shock wave in the grain trade considered to be the largest since the 1970s (The World Bank, 2022; The International Grains Council, 2024). Based on press releases and available data, a synthesis of the main events surrounding the military conflict in Ukraine and grain SCs is presented in Appendix 2.

4.2. Ukrainian 'legal' grain SCs and the aftermath of the war

Owing to its rich soil, different varieties of grain are produced and exported from Ukraine (wheat, corn, sunflower, and other cereals) using road and rail networks and ports in the Black Sea (Chornomorsk, Odesera, Yuzhnyi, and Mykolaiv). Production is geographically concentrated in specific regions of the country: wheat in the south, sunflowers in the east, and corn and soybeans in the north-central regions. Five grain shipping routes (labelled A to E) were identified (Fernandes *et al*., 2023). Because the city of Kropyvnytsky is located at the centre of grain production, it can be considered as the point of origin in the chain. However, given that many countries importing grain are located in the Middle East and Africa, we can

consider the port of Alexandria in Egypt as the main destination port. Before the outbreak of the conflict, grains were mostly exported using route A (from Kropyvnytsky to the port of Yuzhnyi via railroad and then loaded onto a Supramax bulk carrier bound for Alexandria). The other routes (B, C, D, and E) became the only practical alternatives after the siege of the Ukrainian Black Sea ports (Figure 1). Route B involves transporting grain by road to the port of Izmail to be shipped by Handymax bulk carriers to Alexandria. Route C is based on the railway transportation of grain to Izmail and shipping by Handymax to Alexandria; however, owing to military operations in Ukraine, many sections of the railroads have become unusable. Route D ships grain to Izmail, which is then transported on large barges along the Danube to the port of Constanta in Romania and then transported by Supramax bulk carriers to various destinations. Finally, on Route E, the grain is transported via rail to the port of Yuzhnyi, where it is loaded onto Handymax bulk carriers and transported to Alexandria. The war has hampered the traditional Route A transportation route, and its alternatives B, C, D, and E are considered more limited and costlier alternatives (Fernandes *et al*., 2023).

Figure 1 Ukrainian grain-shipping routes



The map is elaborated courtesy of www.mapswire.com and is provided under a Creative Commons (CC-BY 4.0) licence.

The main actors in grain SCs are agricultural producers and farmers who use resources for production, collection, and preparation for product storage. Traditionally, the main distribution

channels for crop products include processing enterprises, domestic market sales, and exports, with the majority of production (70%) purchased by traders (Kuts and Makarchuk, 2022).

Grain exports from Ukraine dropped significantly at the start of the war, with a slight recovery after the Black Sea grain initiative allowing the export of grain to resume (BBC, 2022: The Council on Foreign Relations, 2024). In addition to the blockade of ports, there was a significant decrease in fertiliser exports from Russia. These exports are instrumental in growing and harvesting grain, and their reduction results in increased costs and puts the entire SC under pressure (Bloomberg, 2022).

A low level of logistics capability is also evident in farms in Ukraine; for example, many grain elevators are technically out-dated and highly energy-inefficient (Trachova *et al*., 2022). Experts note that the realisation of Ukraine's export potential is significantly hampered by logistical problems. This is particularly true for rail transportation, which currently plays a major role in the transportation of grain cargo (Rudyk *et al*., 2023; Fernandes *et al*., 2023). In Ukraine, the logistics component of exported grain costs amounted to 35% before the eruption of war (Medvedev, 2019), and following the expiration of the Black Sea grain deal in 2023, the logistics costs have surged (UGA, 2023).

Overall, logistics problems have always hampered grain SCs in Ukraine, especially in terms of bulk transportation, Owing to the lack of multimodal transport solutions and the stretched capacity of seaports to handle bulk grains (Li *et al*., 2023). Furthermore, rampant corruption hampers grain SCs (OCRP, 2023), with many Asian buyers preferring to deal with large traders rather than contracting directly with Ukrainian companies (Australian Export Grains Innovation Center, 2021).

4.3. Illegal grain SCs (black grains)

Based on the available data, we identified two main ISCs: (i) fraudulent SCs using tax evasion schemes to sell Ukrainian grain in the EU and other countries, and (ii) looted-grain SCs in which Russian authorities seize Ukrainian grain and sell it to other companies via Turkish ports.

4.3.1. Fraudulent grain SC

Ukraine's agricultural sector suffers from corruption as documented by an investigation led by the OCRP (OCRP, 2023). Trade data obtained by reporters show that, in the first seven months of Russia's full-scale invasion in 2022, much of the grain passing through the Romanian border (Halmeu) was exported by dubious Ukrainian companies accused of tax evasion, money laundering, and other crimes (OCRP, 2023).

It is estimated that nearly 20% of Ukrainian grain is exported using grey schemes (All About Feed, 2023). Usually, this means that grain is purchased from farmers for cash by dubious

companies who "transfer products from one 'shell company' to another firm to 'confuse' the trade chains and avoid paying mandatory payments to the budget" (OCRP, 2023). The 'shell' firms participating in black-grain fraud appear to change ownership quite frequently, with some of them having been established for merely a year prior to Russia's invasion (OCRP, 2023). Reporters have found that persons listed as owners of such shell firms in Hungary and Czechia often act as proxies who were approached by real fraud perpetrators to join their firms unwittingly (OCRP, 2023). In such grey schemes, grains from Ukraine are exported using fake documentation, and the business is liquidated shortly afterwards to avoid the return of foreign exchange revenue to Ukraine (All About Feed, 2023). By avoiding tax, the Ukrainian black-grain price decreases substantially in the European market and explains the increase in such illicit activities. Between 2019 and 2022, reporters found that the importation of Ukrainian grain through 'shell firms' into Europe amounted to over $600 million and were then resold to other clients from Turkey, Belgium, Romania, and numerous African countries (OCRP, 2023). Fraudulent grain exports are estimated to cost Ukraine between $4 and $6 billion in non-returned export revenue (All About Feed, 2023).

Ukrainian authorities have investigated more than 300 companies suspected of defrauding the state of at least $140 million in 2022 and have seized tens of thousands of tonnes of grain from some companies (OCRP, 2023). Additionally, multiple high-ranking Ukrainian officials, including senior customs officers working at ports in the Odesera region, have been accused of abusing their positions to help set up tax evasion schemes (OCRP, 2023). Stimulated by corruption, black-grain fraud is facilitated by the lack of control and inspection by customs officials in Ukraine (OCRP 2023).

Given that grain sales represent 20% of Ukraine's export earnings (Pavlenko *et al*., 2023), and concerned by the increase in illicit trade, the Ukrainian Verkhovna Rada Committee on Finance, Tax, and Customs Policy supported two bills in November 2023 aimed at combating black-grain exports and the non-return of foreign currency earnings by setting a minimum price under which Ukrainian farmers could export grain (All About Feed, 2023).

4.3.2. Looted-grain SC

Ukrainian authorities claim that Crimean ports Kavkaz and Sevastopol are being used to export grain looted from their occupied southeastern regions. GPS trackers have shown stolen trucks driving through Crimea and Russia (The Moscow Times, 2023). Ukrainian grain is being exported disguised as Russian produce—hence the term 'looted" grain to characterise the activities of smuggling grain by Russian authorities, not for military purposes or to satisfy the needs of the population but for motives of personal illegal profit (The Guardian, 2023).

The pillage of Ukrainian grain and seizure of agricultural infrastructure by Russian and affiliated actors appears to be part of a pre-planned effort to illegally extract resources and profits from Ukraine (The Moscow Times, 2023). These operations have enabled Russians to steal up to 12,000 tonnes of grain per day (GRC, 2023) and gain billions of dollars in sales. The looted-grain SC involves seizing Ukrainian grain storage facilities, confiscating produce, forging documents to disguise the origin of goods, building new railways, and transferring large cargo ships to Black Sea ports (The Guardian, 2023). Additionally, Ukrainian farmers in occupied regions are forced to sell their crops very cheaply (Financial Times, 2022) or risk being subjected to torture and detention by the Russian Occupation Secret Police (The Guardian, 2023). Analysis of satellite photographs by the Financial Times has demonstrated the extent of grain smuggling and exports from the Sevastopol terminal, with the volume of stolen goods amounting to 500,000 tonnes (Financial Times, 2022). Russian state media acknowledged that grain was being sent from Melitopol in occupied south Ukraine to be exported from Crimea (Financial Times, 2022), and this news was presented as a "successful sale" of agricultural products (Rudyk *et al*., 2023). Owing to its strategic location and adequate infrastructure, shipping grain via Crimea is relatively easy, and increasing trade through Sevastopol benefits Russia's attempts to build acceptance of its annexation of the peninsula (Financial Times, 2022).

Some techniques used by Russians include combining grain stolen from Ukraine with other grains from legal sources, thus making tracing difficult. Ships transporting stolen grain use false documents that show Russian cities as their ports of origin. Ships are supposed to automatically report their locations and routes to other vessels and ports, but those carrying looted grain simply "go dark" by turning their transponders off when they approach Crimea and pick up illicit cargo (Financial Times, 2022). Tracing ships transporting illegal grain and using fake bills of lading, cargo documents, and certificates of origin is difficult. The port of Kavkaz is the centre of illicit trade because it facilitates the ship-to-ship transfer of goods while at sea, making it difficult to identify where the cargo was initially loaded[1].

The systematic targeting of Ukraine's grain-rich southern regions occurs with the involvement of "oligarchs" from the Russian President's close circle (The Guardian, 2023). The Guardian provides an example of United Grain, a holding company owned by Russia, with a quarter of

[1] The Financial Times was able to document how ships coast into Port Kavkaz with their transponders on before or after heading to Crimea to be filled, thus creating the impression that they were loaded in the Russian port. Paperwork has shown ships reporting to Russian authorities that they were filled in Sevastopol but telling other governments that they were loaded in Port Kavkaz.

the shares acquired by Taimuraz Bolloev. Before the eruption of the armed conflict, a sanctioned Russian firm, Crane Marine Contractors (CMS), bought two large grain ships in December 2021. The firm purchased a third ship, Matros Posynich, just two days before Russia's full-scale invasion. All three ships visited Turkish ports in 2022, and Matros Posynich was identified in Syria. The vessels often appear "dark" on ship-tracking software, a common giveaway in maritime smuggling operations (The Moscow Times, 2023). In Luhansk and Zaporizhzhia, grain elevators were reregistered for Russian businesses linked to the state grain company OZK which the United States sanctioned in February 2023 for their role in redirecting Ukrainian grain to Russia (GRC, 2023).

Railways linking occupied Luhansk with the Russian city of Rostov-on-Don have been rebuilt, enabling stolen grain to travel over land. Press reports revealed the involvement of Leonid Pasechnik, the leader of Luhansk's Republic, in orchestrating the 13-wagon-train transportation of 650 tonnes of Ukrainian grains to Rostov (GRC, 2023). The main destinations for stolen grains are Syria and Turkey (The Guardian, 2023).

Loopholes in the sanctions regime (The Guardian, 2023) and a lack of political will seem to encourage looted-grain SC activity. Turkish authorities explain their reluctance to apply sanctions on looted-grain activities by citing the risk of setting a dangerous precedent if they detain a commercial vessel without sufficient evidence (Financial Times, 2022). Finally, despite the sanctions aimed at Russian state firms, some companies involved in grain smuggling were not included (Atlantic Council, 2023).

4.4. Enablers of ISCs

We synthesized the enablers of ISCs based on our discussions with experts (sample quotes from the discussions with experts are presented in Appendix 3), along with the data gathered from documentary enquiry. The motivation/pressure behind both ISCs was initially described by most experts as driven directly by the pursuit of "profit and nothing else," quoting Expert 1. However, upon introducing the basic components of the Fraud Diamond framework, several experts highlighted the influence of geopolitical instability and the lack of alternative ways to export grain. For example, Expert 3 explained that, in the looted-grain SC, "geopolitical disruption created by the war between Ukraine and Russia has forced Ukrainian farmers to sell their grain to shell companies" and "to surrender their crops to Russian authorities and their affiliates." In terms of opportunity, all the experts stated that the war in Ukraine created favourable conditions for developing ISCs due to insufficient control. Experts 3, 5, and 6 noted rampant corruption, while Experts 5, 6, and 8 mentioned inefficiencies in logistics. This environment enables fraud and the theft of grain to be committed with relative impunity and

without significant consequences for ISC members. Along the same lines, Expert 4 stated that "it is easy for shell companies committing fraud to escape scrutiny." Additionally, all the experts agreed that illegal activities offer lucrative opportunities and profits.

Capability is another critical enabler, requiring a specific set of skills and resources. These include the ability to forge documents, the capacity to coerce other members, the manipulation of devices to evade tracking, turning off transponders, recruiting the right people to facilitate trade (as noted by Experts 3, 6, and 8), creating shell firms (Experts 3 and 8), hiring and enrolling associates and partners as proxies (Expert 8), and mastering trans-shipment and maritime logistics (Experts 6, 8, and 9).

Finally, the rationalisation of ISC practices is linked to several factors. For Russia, as asserted by Expert 7, plundering and stealing grain represents a case of SC weaponisation, specifically "using the grain SC to obtain political concessions and put pressure on Ukraine." Expert 3 added that "geopolitical instability created by war has made ordinary exportation of grains difficult." Evidence from documentary sources of logistics bottlenecks and the lack of modern SC infrastructure was also corroborated by Experts 5 and 9.

4.5. Illegal grain SC network design

We asked experts to categorise both types of grain ISCs and assess them as hybrid networks with legal and illegal segments. According to Expert 5, "Fraud ISC is based on partially legal exportation of grain with forged documents and shell companies to avoid taxes". However, according to Expert 6, the "looted-grain ISC is based on plundering Ukrainian produce disguised as Russian grain to be sold elsewhere as legitimate operations". In conflict zones, such as the war in Ukraine, ISCs are conducted through various organisational structures, reflecting the diversity in how illicit activities are conducted.

For the fraudulent grain SC, the level of formalisation is high (i.e. the existence of standard and explicit procedures) because the activities are run by shell firms that conduct legal activities, but the illegal activity consists of evading taxes. Expert 3 particularly underlined the fact that "fraud grain is exported by many shell companies which suggests their following of standard 'procedures' and a high level of formalisation to ensure the success of their activities". In contrast, the looted-grain SC is undertaken in a completely informal way, in which there are no explicit rules or formalised procedures, and such criminal activities are mainly conducted by armed forces in collaboration with oligarchs who use their power to profit from such illicit trade.

Regarding centralisation and the concentration of power, Experts 2, 5, and 7 indicated that illicit trade (looted and fraudulent grain) is managed by networks in which hierarchy is important,

and power is concentrated. In particular, Expert 8 remarked that a looted-grain ISC is "orchestrated by Russian authorities and their affiliates" and "Russian forces and high-ranking officials are the ones accused of committing such crimes". Expert 6 noted that "given the hierarchical nature of army forces (…) we can assume that power is highly centralized in such ISCs".

Concerning density and connectedness, no explicit data exist regarding the connection of ISC members. However, according to Expert 5, both looted-grain and fraudulent SCs can be considered as "relatively dense" because these activities take place in a limited geographical area (southeastern Ukraine) and coordination between members of such networks is needed. Expert 3 stated that such connectedness is a bit "peculiar…we are not talking about companies connected with each other in a network… those 'shell companies' that are composed of several members (…) are not necessarily tied to each other". Expert 6 stated that "I cannot be sure whether every member connects with everyone else (…) or whether that would make a highly coordinated network". However, the nature of illicit activities implies that "there are some connections that have been made but at a certain level each activity/tier is not supposed to be tied with the other" as reported by Expert 5. Finally, both the looted-grain and fraudulent SCs can be considered as highly diverse and complex with the existence of various network members utilising various capabilities including forgery, manipulation devices, transshipment, creation of shell firms, and the involvement of proxies in illicit trade.

4.6. The integrative framework of ISC structure and enablers

Based on these findings, we provide an integrative framework connecting the ISC structure and its enablers. To facilitate the presentation, we assess each element of SC network design (formalisation, centralisation, density and complexity) on a scale from low to high, consistent with previous studies on SC design (e.g. Kim *et al*., 2011; Bellamy *et al*., 2014). According to the Fraud Diamond theory, motivation/pressure to commit fraud can exist at a high (intense) or low (mild) level, fraud opportunities can be characterised by their facility (easily performed with impunity) or difficulty owing to scrutiny, law enforcement, and retribution, and capabilities can be highly diverse or limited. Rationalisation is omitted because it relates to how individuals and organisations justify their actions, and no explicit information that can be connected directly to SC formalisation, centralisation, density, or complexity exists. Experts 3, 5, 6, and 7 helped us compile and finalise the data in Tables 2a and 2b.

Table 2a Fraudulent grain SC characterisation

ENABLERS

		Motivation/pressure	*Opportunity*	*Capability*
STRUCTURE	Formalisation	**High pressure** **High formalisation**	**Relatively easy** **High formalisation**	**Diverse capabilities** **High formalisation**
	Centralisation	**High pressure** **Moderate centralisation**	**Relatively easy** **Moderate centralisation**	**Diverse capabilities** **Moderate centralisation**
	Density/connectedness	**High pressure** **Dense SC**	**Relatively easy** **Dense SC**	**Diverse capabilities** **Dense SC**
	Complexity/diversity	**High pressure** **High complexity**	**Relatively easy** **High complexity**	**Diverse capabilities** **High complexity**

Source: Authors

In the fraudulent grain SC, the level of formalisation is high because of the existence of a legal component in the grain trade that coincides with the facility to commit fraud, all of which require several capabilities (technologies, creation of shell firms, and networking). This ISC can be considered moderately centralised and dense, with armed conflict limiting routes and channels to export Ukrainian grain. The fraudulent grain SC can be considered highly complex network involving several entities with various roles and diverse capabilities.

Table 2b Looted-grain SC characterisation

ENABLERS

	Motivation/pressure	*Opportunity*	*Capability*
	High pressure	**Complete impunity**	**High diversity**

STRUCTURE	Formalisation	**Low formalisation**	**Low formalisation**	**Low formalisation**
	Centralisation	**High pressure** **High centralisation**	**Complete impunity** **High centralisation**	**High diversity** **High centralisation**
	Density/connectedness	**High pressure** **Dense SC**	**Complete impunity** **Dense SC**	**High diversity** **Dense SC**
	Complexity/diversity	**High pressure** **High complexity**	**Complete impunity** **High complexity**	**High diversity** **High complexity**

Source: Authors

In the looted-grain SC, the level of formalisation is low because the confiscation and theft of grains are undocumented; however, such illegal activities require a high level of organisation and control. The looted-grain SC is a highly centralised, dense, and complex network requiring several capabilities, skills, and connections.

5. Discussion

Regarding our first research question (*RQ1:* What are the factors (enablers) behind the illegal practices adopted by the Ukrainian grain SC?), the findings underline the existence of two ISCs: fraudulent grain and looted-grain SCs which possess similarities and differences in terms of enablers (motivation, opportunity, capability, and rationalisation).

Concerning our second research question (*RQ2:* How do these enablers affect the structure (design) of the illegal grain SC in Ukraine?), the results of our research have helped us provide several propositions.

We suggest that the level of formalisation in an ISC is shaped by the functional demands of the crime, influenced by the nature of the activity and the power dynamics within the region. Formalisation becomes critical when illicit operations intersect with legitimate markets, as observed in the fraudulent grain SC. Similar to counterfeit goods SCs, formalisation ensures that forged certifications and documentation appear credible to regulatory bodies (Shelley, 2014). Thus, formalisation is accentuated by the necessity to evade legal scrutiny, a hallmark of transnational criminal networks exploiting regulatory loopholes (Kenney, 2007). In contrast, the looted-grain SC demonstrates minimal reliance on formalisation, as coercion and military force wielded by Russian armed forces and separatist groups reduce the need for legal cover.

Historical examples of resource looting in conflict zones further illustrate how power asymmetry enables informal operations without formalised structures (e.g. Felbab-Brown, 2017). These contrasts highlight that formalisation is driven by the operational demands of the crime and the influence of dominant powers, rather than merely by enablers such as motivation or capability. Based on previous premises, the following proposition is advanced:

P1. The formalisation of an ISC is determined by the operational requirements of illegal activities and the presence of powers facilitating illicit trade, rather than the existence of enablers affecting illegality.

Centralisation in ISCs emerges as a strategic response to the complexity and scale of operations driven by strong motivators, opportunities, and capabilities. Addressing the challenges that create this complexity requires hierarchical control to maintain cohesion and operational efficiency. This aligns with studies on drug trafficking networks, which reveal that higher centralisation is associated with substantial logistical and financial enablers, necessitating structured hierarchies to manage resources efficiently (Kenney, 2007; Morselli, 2009). In the fraudulent grain SC, the need to coordinate complex activities, such as document forgery and evasion of taxes, necessitates centralised control to ensure operational efficiency. Similarly, in the looted-grain SC, centralisation stems from the authoritarian control exerted by ruling powers and armed groups, as well as the demands of managing logistical operations using various techniques (transshipment and transponder manipulation). Based on such analysis, we emit the following proposition:

P2. The greater the mobilisation of enablers to address the challenges in undertaking illegal practices the more centralised the ISC becomes.

Density and connectedness within ISCs are shaped by the contextual environment in which they operate. In conflict regions, the degree of network density is influenced by the stability of the area and the level of control exerted by ruling powers. In regions characterised by fragmented governance or active conflict, illegal networks often exhibit lower density and weaker connections allowing for greater flexibility and reduced risk of detection (Felbab-Brown, 2017). Conversely, in areas under the control of ruling powers, illegal networks tend to have higher density and interconnectedness, as the threat of external interference diminishes (Cockayne, 2016). The looted-grain SC may exhibit sparse network density in contested areas where actors operate independently to minimize risks. In contrast, in areas under separatist or Russian control, network density may increase due to consolidated coordination enabled by dominant ruling powers. This dynamic is supported by the findings on conflict mineral SCs, where

network density 'fluctuates' depending on the region's stability and governance (Shelley, 2014). Therefore, the following proposition is emitted:

P3. The density of ISCs in a conflict region is contingent on the situation in the geographical area and the influence of ruling powers rather than the existence of enablers facilitating illegality.

Complexity in ISCs arises from the need to manage diverse operational challenges while exploiting opportunities for profit and evading detection. Enablers such as advanced technological capabilities, high profit margins, and logistical opportunities intensify this complexity by necessitating sophisticated methods and involving diverse actors. For instance, ISCs dealing with counterfeit goods employ methods such as transshipment, forgery, and tracking manipulation to evade detection (Interpol, 2020). Similarly, in the grain ISCs, activities like forging export documents, tampering with transponders, and utilising transshipment routes illustrate how enablers magnify network complexity. Comparable dynamics are observed in a complex network of organized wildlife trafficking where enablers such as bribery, fraudulent permits, and multi-modal transportation systems support such illegal activities (UNODC, 2020). This interplay between enablers and operational methods demonstrates that complexity is dynamic, evolving with the strength and diversity of the enablers. Advanced logistical capabilities, such as maritime expertise, adds layers of operational sophistication, underscoring how enablers intensify the complexity of ISCs by addressing logistical, legal, and tactical challenges.

Consequently, the following proposition is suggested:

P4. The complexity of ISCs is amplified by robust enablers such as motivation, opportunities and capabilities that facilitate and support their illegal activities.

6. Conclusion

6.1. Theoretical contributions

Our study responds to recent call from several scholars (Pullman *et al*., 2024; DuHadway *et al*., 2022) for a more comprehensive investigation into the factors driving fraud and illegal activities in SCs. By adopting a sociopolitical perspective, we emphasise the intricate interplay of political, economic, and social factors, illustrating how these forces collectively trigger and sustain ISCs. This approach provides a transferable framework that transcends the Ukraine-Russia war context, offering insights applicable to other scenarios where disruptions - geopolitical, economic, or environmental – expose SC vulnerabilities.

While previous research has underscored the importance of contextual and institutional environments in shaping criminal SCs (Oglethorpe and Heron, 2013; Smith and McElwee, 2021), our study is the first to examine how factors such as geopolitical disruptions, logistical inefficiencies, and infrastructure deficiencies contribute to ISC activity. These challenges, often arising during systemic crises, are critical to understanding ISCs in high risk regions or periods of widespread disruption.

By exploring ISC enablers - motivation, opportunity, capability, and rationalisation - our research reaffirms the relevance of the Fraud Diamond theory for analysing illegal activities. Unlike earlier studies which largely attributed such activities to profit motives (Arnold *et al.*, 2012; DuHadway *et al.*, 2022), our work broadens the scope by integrating sociopolitical and logistical perspective. This approach provides a more holistic understanding of ISCs by revealing how structural and systemic vulnerabilities enable illegal practices. While prior research often focused on the opportunistic behaviour of individual SC members (DuHadway *et al.*, 2020; Yazid *et al.*, 2020), we extend this view by incorporating concepts from SC design, criminology, and legal studies to examine how entire networks facilitate these behaviours.

Our focus on ISC network design reinforces the structural perspective on fraudulent SCs, advancing previous research in new directions (DuHadway *et al.*, 2022). Earlier studies demonstrated how network characteristics, such as length and complexity, increase exposure to illegal activities (Arnold *et al.*, 2012; Asbjørnslett, 2009). We expand this understanding by analysing multiple dimensions of ISC such as formalisation, centralisation, density, and complexity as interrelated dimensions that influence ISC operations. This nuanced perspective of network design highlights how organizational structures interact with enablers to shape illicit activities, offering a framework for analysing ISCs across diverse contexts.

We proposed an integrative framework combining the Fraud Diamond and SC network design theories, linking ISC enablers - motivation, opportunity, and capability - with structural dimensions such as formalisation, centralisation, density, and complexity. This framework is not only relevant for understanding ISCs in conflict-affected regions but also serves as a robust tool for exploring illicit SCs in other high-risk contexts, such as conflict minerals or humanitarian aid. Furthermore, our propositions on the interplay between enablers and network characteristics lay the groundwork for future research into ISCs, ensuring the continued relevance of these insights as the global SC landscape evolves.

6.2. Practical contributions

Understanding ISC design and enablers is a critical first step toward developing more effective sanctions that target perpetrators and dismantle their capacity to develop their ISCs and commit

crimes. Our findings can be informative for government authorities and policymakers in formulating measures aimed at addressing illegality in SCs.

We propose a multifaceted approach to curbing ISCs activities by addressing both enablers and network structures. One essential mechanism involves identifying how ISCs leverage their network characteristics - such as complexity, formalisation, centralisation, and density -to circumvent sanctions, evade legal scrutiny, and sustain their operations. This knowledge can inform the development of targeted measures, including sanctions, regulatory controls, and inspections, designed to minimise opportunities, constrain capabilities, and disrupt ISC members' ability to mobilise their resources effectively. Several specific actions can be implemented to combat ISCs activities and illicit trade. For example, enhancing tracking, tracing, and visibility of grain operations related to fraudulent grain exported from Ukraine and looted grain transiting from areas under Russian control, can significantly diminish the operational capacity of these criminal networks. Additionally, efforts to reduce the diversity and complexity of ISCs should focus on limiting their use of capabilities - whether technological, managerial, or network connections - and exposing the involvement of actors such as shell companies, high-ranking officials, oligarchs, and separatist groups in illicit trade. Finally, reducing ISCs' connectedness and their capacity for networking and coordination can be achieved by imposing comprehensive sanctions on all participants and restricting their control over geographical areas where illegal activities occur with impunity.

6.3. Research limitations and further research opportunities

Studying ISCs in a geopolitical context is a challenging area of research, particularly in empirical investigations. An obvious limitation of this study is its reliance on secondary data. Expert interviews were conducted to provide the perspectives of practitioners and scholars interested in this topic. Another limitation is the focus on understanding ISC design and not sufficiently delineating the mechanisms behind the relationships that stimulate or hinder illegal activities. In particular, ISC governance and issues of profit and transaction costs may represent potentially fruitful future research.

The emergence of ISCs in the context of geopolitical disruption has strong potential for both developing theories and enriching discussions on practical measures to combat crime and fraud. Based on our set of propositions, research might be conducted to examine further the validity of our propositions either using conceptual and/or empirical tools. Furthermore, other avenues of research can integrate theories other than the Fraud Diamond framework to examine aspects related to trust and risks in ISCs. For instance, to what extent does the ISC design require a

level of trust between network members? What types of risk determine the survival and continuity of ISCs?

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