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Theft of oil from pipelines: an examination of its crime commission in Mexico using crime script analysis

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ABSTRACT

The theft of refined oil products provides criminal groups with significant financial resources that threaten the environment and socio-economic stability of countries where it occurs. Violence is also associated with this criminal activity. Using crime script analysis, a detailed interpretation of the theft of oil via the illegal tapping of pipelines in Mexico was constructed. The analysis revealed the roles performed by members of criminal groups, the recruitment of individuals outside of the criminal group to provide information about the pipelines and perform technical activities, and the supporting role of citizens and businesses from local communities. The analysis also revealed the decision-making necessary for the successful commission of oil theft via the illegal tapping of pipelines. The use of situational crime prevention measures and improvements in the use of deterrence are identified as offering opportunities for preventing this criminal activity.

Introduction

The theft of refined oil products[1] (TROP) provides those who are engaged in this criminal activity with significant financial resources, deprives governments of billions of dollars in lost tax revenues, and creates instability where it occurs[2]. The global financial impact from stolen oil is estimated to be over USD 133 billion per year[3], with organised crime groups (OCGs) increasingly turning to TROP as a source of income[4]. Mexico has experienced significant increases in TROP in recent years. With proven reserves that amount to approximately seven billion barrels of oil[5], Mexico is an attractive target for oil thieves. Oil theft in Mexico is mostly committed via illegal pipeline tapping (IPT)[6]. In 2018, over 34 incidents of IPT were recorded per day in Mexico[7]. All of Mexico's main OCGs[8] – Cartel Jalisco Nueva Generación, Los Zetas, the Gulf Cartel, and the Sinaloa cartel – as well as over 30 smaller groups, are involved in TROP to some degree[9]. In 2018 it is estimated that oil thieves in Mexico (locally known as *huachicoleros*) stole, on average, 58,200 barrels of oil per day, equivalent to USD 4.1 million per day[10] in lost revenues[11]. Although government action in Mexico to address TROP has increased since 2019, TROP and the violence associated with it continues to be a problem[12]. TROP is also likely to be supported by individuals who are not members of OCGs: Some of whom may be connected to the oil

industry; others who make use of the stolen refined oil products, or; are employed in law enforcement or government. However, due to the clandestine nature of TROP, little is known about the activities involved in its crime commission.

This paper contributes to the global knowledge base of TROP and IPT with a specific examination of this criminal activity in Mexico. We illustrate how a complex and clandestine criminal activity can be better understood by using crime script analysis, and reveal the roles performed by those involved in TROP and IPT. By completing the analysis, we identify opportunities for interventions that can counter this criminal activity. Before a description of the methods used, we describe TROP more fully, the illegal supply of refined oil in Mexico as an organised crime problem and explain the theoretical grounds for the analysis. Results are then provided, followed by a discussion of the findings, limitations, and conclusions.

TROP as a global crime problem

TROP affects a large number of countries. In Nigeria, for example, in 2018 oil theft accounted for financial losses of USD 1.5 billion per month[13]. Violent clashes between rival criminal groups competing for the profits available from TROP has been responsible for the loss of approximately 1,000 lives annually in Nigeria. In turn, these clashes disrupted oil production, and had wide-ranging economic consequences. Kidnapping, armed robbery and attacks against oil industry personnel and installations have also increased[14]. Many in Nigeria, however, consider oil theft as being legitimate, especially amongst minority groups[15], 'taking albeit illegally, what naturally belongs to them but is appropriated by non-indigenes' in compensation for the exploitation they have experience from the Nigerian government[16]. In Colombia, TROP is associated with the activities of Colombian armed groups who depend on stolen oil to process cocaine and power machinery used in illegal mining[17]. Colombian armed groups also profit from extorting oil companies by threatening to explode their pipelines[18]. The Western Amazonian region also has recently been exploited for its oil reserves, with oil leaks from IPTs causing significant environmental damage and health issues in indigenous communities[19]. In Mexico, TROP is considered mainly to be associated with OCGs, who seek to financially benefit from selling the oil they steal[20].

Since the mid-2000s, former *traditional* drug cartels in Mexico have fragmented, internal and external rivalries between criminal groups have intensified, and criminal groups have diversified their criminal activities[21]. This diversification of activities has varied depending on the territory that each organisation controls[22]. For example, OCGs in Michoacán state have diversified to avocado theft and the extortion of its producers as the avocado industry grew into a multi-billion dollar export industry[23]. With regards to TROP, in 2010, the Los Zetas OCG's traditional arms and drug trafficking activities began to be undermined due to their targeting by rival OCGs and the Mexican Army[24]. As a consequence, Los Zetas turned to stealing and selling oil as an alternative source of revenue as it controlled the municipalities through which several oil pipelines crossed[25]. By 2016, Los Zetas was generating approximately USD 371 million annually from oil theft[26]. Observing the potential profits to be made from TROP, other OCGs in Mexico began to steal and sell oil[27]. As revenue from TROP increased, OCGs in Mexico were increasingly needing to respond to challenges from rival groups equally keen to exploit

TROP opportunities, and from the efforts of law enforcement, the government, and Pemex[28] to counter TROP. Pemex is the Mexican state-owned petroleum company and until 2016 had exclusive rights over exploration, extraction, refining, and the commercialisation of oil in Mexico. Pemex operate all the oil pipelines in Mexico, with the exception of small number that have begun to be built by private companies.

Illegal tapping of pipelines[29] is the most common method used by OCGs in Mexico to steal oil[30]. Between 2010 and 2018, the number of IPTs identified in Mexico increased by 1,720%[31]. In 2018, 12,581 new IPTs were found across Pemex's 17,000-kilometre pipeline network, with increases in incidents continuing into 2019[32]. In 2018, the Mexico Attorney General's Office opened 9,894 cases relating to TROP, from which 1,399 arrests were ordered[33]. Very few of those arrested were charged with sanctions of any great severity, only one percent of those arrested were accused of participating in organised crime, and of these, over half were released without charge[34].

TROP and IPT can have serious consequences for the communities located in the vicinity of pipelines. Not only may these communities be affected by the violence associated with the criminal activity, but also by explosions and environmental degradation caused by oil leaks[35]. This has been observed internationally[36], but a particular example from Mexico illustrates the lethal consequences of TROP and IPT – in January 2019, an explosion in the farming community of Tlahuelilpan caused by an IPT killed 137 people, and resulted in significant pollution and environmental damage[37]. Local communities in Mexico do, however, benefit from TROP, including access to the purchase of cheap gasoline[38].

Although some new law enforcement activity for addressing TROP and IPT in Mexico was implemented in late 2019 (mainly involving an increase in arrests), no research to date has examined the activities associated with this criminal behaviour. In many ways, this is because of its clandestine and complex nature. A better understanding of the activities and individuals involved in the commission of TROP via IPT may identify effective ways to reduce this criminal activity.

Theoretical framework

The rational choice perspective (RCP) offers a way to examine offending by considering the influence that offenders' interactions with the immediate environment have on their criminal behaviour[39]. Criminal behaviour, as the theory states, involves the purposeful aim of fulfiling needs and desires, with the actions that result being rational means to satisfy goals. This means offenders are required to make decisions by estimating the possible costs and benefits associated with their actions[40]. These costs and benefits are constrained by time pressures, skills, knowledge, experience, risks, and access that offenders have to resources, meaning that decision-making is often bounded by the circumstances and situations within which offenders operate. RCP provides a useful theoretical framework for examining TROP via IPT because oil thieves need to make decisions that consider the potential risks and costs involved, determine if challenges to their activities are not insurmountable, and whether their efforts are not outweighed by the benefits to be gained. RCP also emphasises that criminal decision-making is crime specific, and that factors offenders consider when making event decisions (such as the choices made before, during and after the crime commission process) require detailed examination[41].

In the case of TROP via IPT, these event decisions may relate to the route that is taken to reach a pipeline, the time of day to extract the oil, and how to store stolen oil. For offenders to perform criminal acts, they also may need to involve others to play supporting roles. For crimes involving many associated activities, offenders must locate the resources required to perform activities and decide who does what in the crime commission process.

Offender decision-making within criminal activity is, however, only one of several components associated with a crime event. Crime events are the result of the confluence of offenders who are motivated to commit a crime, seeking targets that are suitable, while controllers (such as those who can intervene if they suspect illegal behaviour) are ineffective or absent[42]. These theoretical principles (taken from routine activity theory) help explain, for example, how the extensive oil pipeline network in Mexico, and the locations where pipelines cross, make the convergence of offender and target, without controllers (e.g., the lack of security patrols), opportune for IPT. These principles can be applied to many events within a crime commission process. For example, the opportunity to sell stolen oil is also subject to the convergence in time and space of sellers and buyers, absent of the presence of effective controllers.

Complementary to the rational choice perspective and routine activity theory is deterrence theory, which emphasises that individuals are profit maximisers who consider criminal activity against the costs (losses, threats and efforts) involved. Deterrence theory asserts that people are discouraged to commit crime if they believe there is *certainty* of being caught, and that the punishment will be *severe* and *swift*[43]. Studies that have examined these three components have shown that the certainty of being caught for a criminal act has a greater impact in deterring offending than the severity or swiftness of the punishment[44]. Preceding the imposition of any punishment associated with a criminal act is the consideration by the offender of whether the act will lead to them being arrested. That is, the offender needs to believe the act is risky to perform for them to be deterred. Impunity in Mexico is very high[45], corruption of public officials in the country's criminal justice system is not uncommon[46], which in turn can make those individuals involved in TROP assume, that even if they are arrested, they are unlikely to be prosecuted for engaging in this criminal activity. This deterrence framework can be used to understand the attraction to TROP by offenders in comparison to their perceptions of arrest and prosecution.

Crime script analysis and its use for identifying opportunities for intervention

Building on RCP, Cornish proposed that if criminal activity is goal-oriented, consists of a sequence of tasks or sub-goals, and requires knowledge and experience for tasks to be successful, then criminal behaviour, could be a function of its learnt and routinised production[47]. From this, the notion of crime scripts was conceived, borrowing from cognitive science, as a means to better understand crime commission, and the decision-making associated with criminal acts[48]. Scripts are theorised knowledge structures that organise the thoughts and experiences of social interactions and the roles people perform, so they behave appropriately in response to others' behaviour. Scripts emphasise upon the causal relationship between events in a sequence (such as how early events

enable the occurrence of later events), and upon explanations about specific actions performed within a wider activity. Crime scripts detail the logical steps adopted by offenders to prepare for, undertake and complete a crime, with crime script analysis (CSA) involving the methodical, systematic study of crime commission constructed from a crime script.

A crime script consists of acts and scenes, involving offenders, facilitators, and settings. It involves recognising criminal activity as a 'dynamic, sequential, contingent, improvised activity'[49] refined from the lessons learnt from previous crime commission. This makes crime scripts useful as analytical tools for deconstructing crime commission by identifying and analysing the steps involved in an offence, and capturing the routine, yet responsive and adaptive nature of criminal decision-making. CSA builds a picture of offender decision-making by uncovering the influencing factors that cause a particular behaviour or choice to occur, elicits greater clarity on the entangled processes involved in offending behaviour, and the activities of interconnected participants involved in illegal activity. Recent examples of CSA have illustrated its use for examining complex criminal activity such as the manufacture and trade of illicit substances[50], human trafficking and exploitation[51], sex offending[52], and terrorism financing[53]. No known study to date has used CSA to examine TROP, IPT, and the illegal supply of refined oil products[54].

The current study used the theoretical principles of rational choice, routine activities, and deterrence theory, within a crime script analysis to examine TROP via IPT. Specifically, the research was guided by testing two hypotheses: Individuals engaged in TROP via IPT in Mexico are rational, and operate within an opportunity structure with ease and freedom; Individuals, or at least their activities and roles they perform, engaged in TROP and IPT can be identified using analysis techniques. Crime script analysis offers potential for identifying how the opportunity and incentive structures to commit TROP via IPT can be removed or changed[55]. This includes identifying potential intervention points that could help prevent and disrupt this criminal activity. From this we proposed a third hypothesis: opportunities exist to prevent TROP and IPT, with these offering viable alternatives to a reliance on the criminal justice system for reducing TROP.

Data and methods

The creation of the crime script involved a four stage process: The production of a crime script template; the identification of data; the selection of data and its population into the crime script using a coding process, and; an axial coding process for examining how categories and subcategories of data related to each other[56].

Cornish[57] introduced a process for the creation of crime scripts involving scenes, consisting of eleven scene classifications, organised in relation to facets and choice-structuring conditions to explain the ways in which a criminal activity could be executed. This process was then streamlined by Tompson and Chainey[58] to offer a more practical approach to crime script creation, to assist in the collection of data for the crime script, and has become a popular template to follow[59]. This template involves organising the key stages of the criminal activity into acts, with each act consisting of scenes, a cast, and conditions. Figure 1 provides details about this template and its components, and is further elaborated upon in Tompson and Chainey[60].

Act: The key stages in the crime commission process. A crime script typically includes multiple acts, with each act consisting of scenes, a cast, and conditions.	
Scene: The settings within which each act occurs and is divided into four classifications	
Preparation	Description of the planning and preparation that is required for the activity to occur
Pre-activity	Description of the activities that occur immediately prior to the activity itself
Activity	Description of the main activity occurring in the act
Post-activity	Description of the activities that occur immediately after the activity itself, and that need to occur to exit the activity
Cast: Description of the participants within each scene, or at least the roles they perform.	
Conditions: The conditions within which the criminal activity occurs, described in terms of three types of conditions	
Prerequisites	The preconditions that need to be satisfied before illegal activity is initiated
Facilitators	The factors that make it easy and profitable to engage in the activity
Enforcement conditions	The legislation, regulations and licensing that govern the act

Figure 1. A crime script template.

Data about TROP via IPTs were gathered from two main sources: recorded data on IPT incidents and open source intelligence (OSINT). Data on IPT incidents that occured in 2018 in Mexico were sourced from Pemex via their online repository[61]. Data from Pemex and other public sources[62] was also consulted for the location of oil pipelines in Mexico, with pipeline routes then digitised in a geographical information system and compared to the number of IPTs by state. The IPT incident data from Pemex were useful in identifying where and when incidents took place but were limited in providing information about the commission of TROP via IPTs, such as how the activities were performed, details on the people involved and the use of equipment for performing activities.

Data gathered via OSINT offered a potential means for examining the nature of the activities associated with TROP vis IPTs. To identify, extract and quality assure OSINT data, document analysis[63] was used. The document analysis used Google Search to identify documents in English and Spanish, consisting of three steps: Step one used over 35 key word searches (such as 'illegal pipeline tap' and 'oil thief') to identify documents of most relevance; step two involved refining the selection of documents by removing redundancy and considering appropriateness of content[64]; and step three involved further refinement in the selection of documents by assessing for their quality, defined in terms authenticity, credibility, representativeness, and meaning[65]. Information was searched from all forms of open sources such as journal articles, Mexican and international media coverage, published journalistic investigations, and reports about TROP and IPT in Mexico from consultancy practices and think tanks. These documents did not necessarily relate to specific incidents or investigative cases into TROP via IPT, but instead could provide

information about the modus operandi of the criminal activities, individuals involved in the activities and the roles they performed, and to elicit information about offender decision making. We give examples in the results section of the type of information these documents provided. To ensure documents were temporally relevant, their selection was restricted to those published between June 2014 to June 2019. This process yielded 1,539 documents after step two, that were then decreased to approximately 100 documents for analysis after step three[66].

The analysis of data on IPT incidents and OSINT led to us to define six acts involved in the crime commission of TROP via IPTs: planning, transportation to the pipeline, oil extraction, transportation from the pipeline, storage, and disposal. These six acts were then used in stage three to organise and code the data in relation to the scenes, cast, and conditions within each act. Data were also coded in relation to the efforts, risks, costs and rewards that offenders considered within each act, in relation to the roles performed within each activity (i.e., the cast), and the equipment required. Full details on this coding regime are provided in Chainey and Alonso Berbotto[67]. The content of the crime script was then examined further using axial coding to determine how categories and subcategories of data related to each other, to determine the decision-making that was necessary in the commission of TROP via IPTs, and to interpret the activities performed.

Result

In 2018, four of Mexico's thirty-two states accounted for over 50% of the 12,591 IPTs (see Table 1). Figure 2 shows the distribution of oil pipelines in Mexico and the number of IPTs

Table 1. IPTs in 2018 by states in Mexico.

| State	Number of IPTs	Percentage of IPTs
Puebla	1815	14.4
Hidalgo	1726	13.7
Guanajuato	1547	12.3
Veracruz	1338	10.6
Jalisco	1273	10.1
Estado de México	1268	10.1
Tamaulipas	1084	8.6
Sinaloa	412	3.3
Tlaxcala	375	3.0
Querétaro	275	2.2
Nuevo León	223	1.8
Morelos	208	1.7
Michoacán	198	1.6
Sonora	167	1.3
Tabasco	166	1.3
Oaxaca	135	1.1
Chihuahua	112	0.9
Baja California	111	0.9
Ciudad de México	83	0.7
Coahuila	28	0.2
Durango	25	0.2
Chiapas	17	0.1
Aguascalientes	2	0.01
Yucatán	2	0.01
San Luis Potosí	1	0.008
Baja California Sur, Campeche, Colima, Guerrero, Nayarit, Quintana, Roo, and Zacatecas all recorded zero IPT incidents		
National	**12,591**	**100**
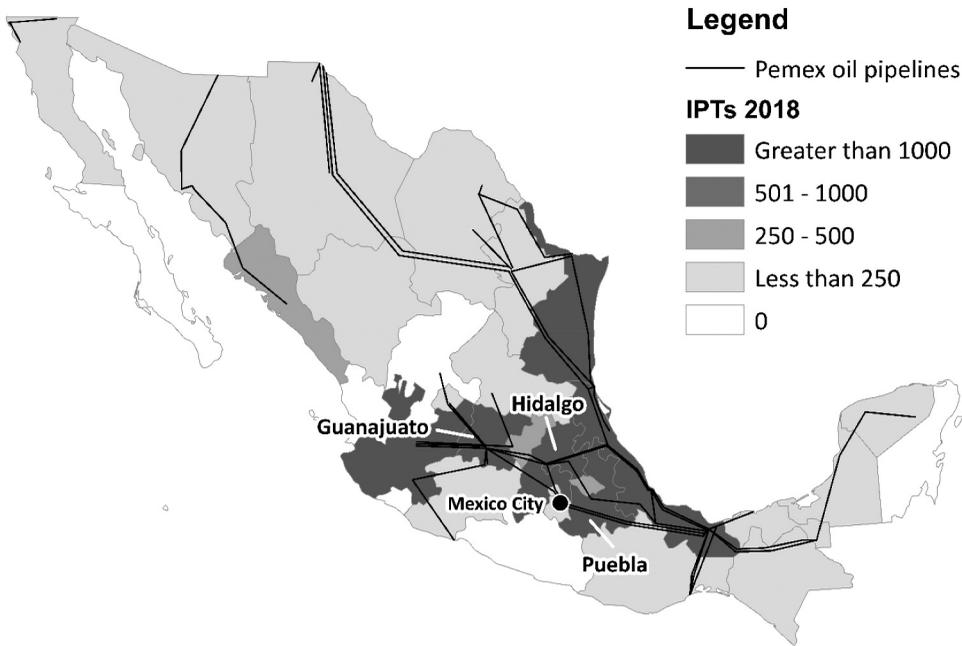
Figure 2. Pemex pipelines and the number of IPTs (by state) in 2018 in Mexico.

by state, indicating that where there were oil pipelines, there were IPT incidents from pipelines. These IPT incidents were greatest in the states with the most pipelines.

Although the Pemex data about IPTs and TROP was limited, the data collected on TROP via IPT using OSINT and document analysis was extensive and of good quality[68]. A description of these findings based on the analysis of the crime scripts follows, and is

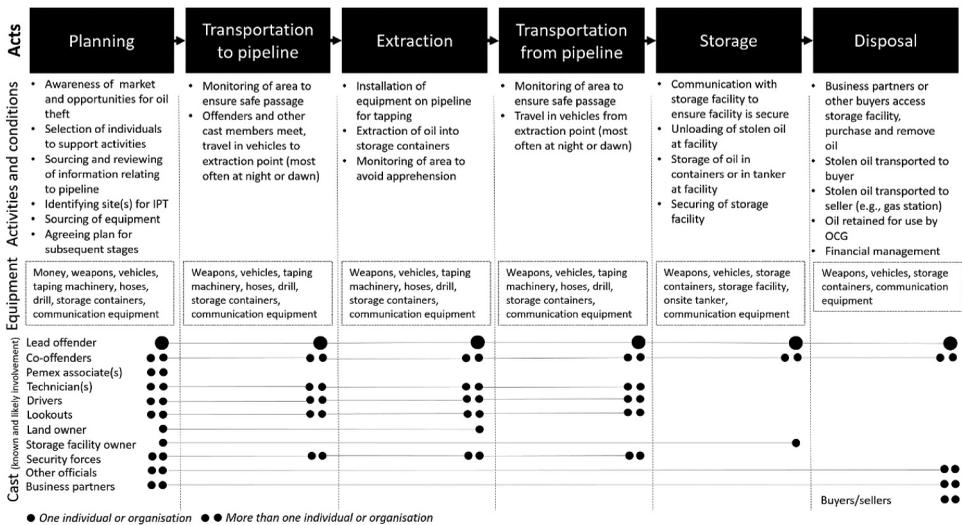**Figure 3.** A summary crime script for TROP via IPT in Mexico.

summarised in Figure 3. The descriptions are based on a synthesis of information from multiple documents, however, we include citations to documents for certain findings.

Crime acts

Planning

The information captured for the planning act identified that offenders were aware of the profitable opportunities from TROP, and that they perceive an absence or lack of effective guardianship protecting the large network of oil pipelines (such as the lack of security patrols along the pipeline's route)[69]. The high demand for oil products meant that stolen oil could easily be sold, with the risk of apprehension minimised by bribing security forces with money, sex and drugs[70]. Identifying a pipeline to target and when to extract oil required knowledge about when oil flow through pipelines was active. Those with this knowledge were recruited by OCGs during the planning stage to provide this information. Members of OCGs had the skills to perform many of the required roles associated with TROP, but also recruited individuals to perform subsequent technical tasks such as installing a pipeline tap, or act as lookouts. Offenders also organised and obtained equipment for conducting TROP during this planning act, such as storage barrels and vehicles. Vehicles were often stolen rather than purchased and were usually modified for transporting stolen oil. TROP via IPT required the involvement of many individuals, required a good level of organisation, and was most likely performed by existing OCGs rather than new groups forming to solely commit TROP. The analysis determined it was likely a lead offender devised the plan, and co-ordinated the activities of individuals.

Transportation to pipeline

Offenders were more likely to operate in areas where they were familiar, and where pipelines were located close to their base, so it was most likely that OCGs that were present and had a controlling influence in the area where pipelines exist were the ones responsible for TROP in these areas. With this local knowledge, offenders were more likely to be able to predict where security checkpoints would be located en route to a pipeline. OCGs were also conscious to avoid encounters with rival OCGs, particularly if they were required to travel across a rival's territory. Thus, lookouts were appointed to monitor and communicate to the travelling convoy the movements of security patrols and other OCGs. The lead offender would decide where support offenders and other associates would meet, the number of vehicles to be used, the route to take, and the day and time to travel to the pipeline extraction point. The cast would travel in more than one vehicle, and at night or dawn to avoid traffic and security personnel. Day and time to travel was also conditioned by when oil was scheduled to be transferred through the pipeline. All offenders were usually armed, and on some occasions the convoy of vehicles was escorted by other vehicles with heavily armed occupants or by corrupted security forces.

Extraction

Pemex personnel were recruited by the OCG to provide information on the type of oil products transported through the target pipeline, and the scheduling for their transportation. Communication between an OCG member on-site and the Pemex associate (who was likely to be off-site) was usually maintained during the extraction process to ensure the success of the operation. Oil thieves targeted pipelines in remote locations, that could be accessed by vehicle, and where they believed there to be an absence or ineffective presence of patrols or surveillance systems. Of Pemex's 17,000 km pipeline, the 9,000 km polyduct network was most affected by IPTs[71]. Pipelines were sometimes located on land that was privately owned, which meant OCGs often bribed landowners, rather than raising attention to their activity from trespassing on the land. Pipelines buried underground were usually no more than two metres below the surface, and signs mounted by Pemex would indicate their exact location. Drilling into pipelines most usually was carried out when oil products were not being transported, to avoid explosions. This meant that on some occasions two visits to the pipeline was necessary: to instal the tap when oil was not flowing through the pipeline, and to extract oil on a subsequent day. Often, only a single visit to the extraction point was performed, with taps installed immediately prior to the known scheduling of when oil flowed through the pipeline. After drilling, a nipple was installed to which a shut-off valve was connected. In some cases, multiple holes were drilled and connected with valves.

When oil was flowing through the pipeline, one to two-inch diameter hoses were connected to the installed valves, and to storage containers mounted on vehicles positioned next to the pipeline. Often, two valves and hoses were installed, with one used to extract oil while the other injected water into the pipeline to maintain the pipeline's pressure and avoid an IPT being detected by Pemex's oil pressure monitoring systems. In these circumstances, additional planning was required to transport water (usually in the containers that would be used for storing extracted oil), as a water source was unlikely to be present at the extraction location. Installing an IPT took approximately 30 minutes. Extraction rates were about 1,000 litres of oil per minute. Once oil storage containers had been filled, the valve was closed, and could be re-used if undetected and not removed. Lookouts ensured the act was performed without disruption.

Transportation from pipeline

Vehicles loaded with large quantities of stolen oil cannot travel at high speed. To avoid detection, and confrontation with rival OCGs, this activity mainly occurred at night or dawn, and avoided main highways where security patrols were more prevalent. Lookouts were used to monitor the route and nearby areas. Offenders were usually armed, and sometimes escorted by vehicles with armed occupants, or by corrupt security forces.

Storage

Storage facilities were usually located near the extraction point. These were often warehouses, or other facilities in the communities located near to pipelines. Offenders would

negotiate a payment or extort facility owners to use the premises (initiated during the planning stage), and in some instances, OCGs would build tankers in these premises. Alternatively, OCGs would acquire land to build dedicated storage facilities. Small, rural towns with marginalised populations near pipelines offered good opportunities for oil storage. Often, members of the OCG were from these communities or had contacts that were used to locate suitable facilities to store stolen oil. Storage facilities were made secure for the arrival of stolen oil, which was unloaded or siphoned from storage containers to tankers. Maintaining the security of the storage facility was vital.

Disposal

The volume of stolen oil was too large for a single party to absorb, so OCGs would identify suitable buyers and business partners. Business partners would include enterprises for which refined oil was a major cost, such as mining or transportation businesses, with negotiations usually taking place during the planning act. Arrangements would be made for the exchange of oil and money (e.g., date, time, and means of transfer). On occasion, OCGs would extort individuals into buying or selling stolen oil for them. This included local gasoline stations. Refined oil would also be sold directly to people from the local community. OCGs would occasionally retain some of the oil for other uses, such as manufacturing synthetic drugs. Money earned by the OCG from TROP would use the OCGs existing money laundering infrastructure. In 2018, at least USD 0.5 M proceeding from TROP was inserted into Mexico's financial systems[72]. Payments would be made to those involved in TROP and IPT activities.

Cast and equipment

The cast involved in TROP and IPT could be broadly divided into four main groups: an operational group, an armed wing, bystanders, and beneficiaries. TROP and IPT most usually involved a lead offender who coordinated activities and headed the operational group. The operational group performed the key operative activities necessary for TROP and consisted of other members of the OCG (e.g., involved in the supply of equipment and recruitment of others), and vehicle drivers. TROP and IPT required people knowledgeable about the pipelines, experienced in tapping pipelines, and illegal market networks that supported the sale of stolen oil. Current or former Pemex employees were involved in a number of these activities. Offenders needed information on the scheduling of when oil would be transported through the pipelines that were targeted for oil theft. Pemex (former or current) employees were involved in providing information on the location of pipelines, scheduling of when pipelines were active, and Pemex's security and detection systems. 135 Pemex staff were arrested for involvement in TROP between 2006 and 2015[73], illustrative of the criminal roles they performed for OCGs.

Corrupt security forces and lookouts formed part of the armed wing, and were hired to protect the operational activities, reduce the risks of being caught or ambushed by rival OCGs or other security forces. The armed wing also included individuals from the OCG who would, if required, extort bystanders. Bystanders were actors involved in performing certain tasks associated with TROP, and included landowners where pipelines were

located, storage facility owners, and government officials. Bystanders were usually threatened or extorted to perform roles that supported the operational activities, rather than benefiting from TROP. For example, government officials would be extorted to not pursue the prosecution of key individuals who were identified or arrested for involvement in TROP. Beneficiaries were those who also profited from TROP, including sellers of equipment to facilitate TROP and IPT, and business partners. Local citizens would often be employed to perform roles that helped facilitate TROP and IPT, and legitimate businesses would often be paid to provide oil storage facilities for OCGs. Offenders involved in TROP and IPT would also transfer their knowledge and skills to other individuals in their OCG, so the OCG could generate further revenue from this criminal activity.

The need for vehicles was present across the criminal activity. Particular vehicles of choice, acquired legally or illegally, included General Motors' S-10, Ford's F-150 and Volkswagen's Bora pick-up trucks. Vehicles were usually older models, 4x4s, and would be adapted with racks to carry 500 to 1,500-litre barrels. Weapons, burner or encrypted phones, and walkie talkies were also required throughout the activity. Specialist equipment was required for pipeline tapping and was not easy to obtain from commercial sources. This equipment was either obtained from Pemex (via Pemex individuals the OCG had recruited) or other specialist providers. Equipment that supports oil tapping, such as hoses and storage barrels could easily be obtained. Licences were not required for purchasing or handling equipment associated with TROP and IPT, but licences were required to transport and store oil[74].

Decision-making across the criminal activity

Risks and costs

Remote areas that authorities find hard to monitor were the specific types of areas exploited by oil thieves, due to the low risk of apprehension in these areas. This low level of risk was further compounded by the high levels of impunity associated with TROP and IPT. Impunity levels were highest in the eleven states that accounted for 90% of all IPTs in 2018[75]. Additionally, security forces and authorities could be bribed, corrupted or extorted, leading offenders to believe that even if caught, the likelihood of prosecution would be low. Heavy sanctions are in place in Mexico to punish oil thieves[76] yet TROP has been rampant in the country, suggesting the severity of punishment has little effect in deterring offenders from TROP. First-hand experience, and from the experience of others engaged in TROP, meant the risks of being caught were largely ignored by offenders because these risks were judged to be low. Risks and costs for involvement in TROP were more compared by offenders against other illegal activities, such as the drugs trade – TROP was perceived to be a safer activity as it avoided the risks associated with smuggling illegal products across international borders[77], and less costly because of the opportunities to sell stolen oil to the large domestic market. As stated by a member of the Los Zetas OCG, 'a friend invited me to work with him [tapping pipelines] and told me how much it would pay. So, I started comparing things, being a thug . . . or to steal from Pemex? I felt it was safer to make money from Pemex pipes . . . many people like money. You can invest, to make a tap, MXN 200,000–300,000, buying tankers, trailers, equipment, and you get it back in one or two days'[78].

An initial investment of approximately USD 16,000 was needed to conduct TROP via IPT[79]. This suggests it is unlikely that individuals operating on their own are involved in TROP and IPT, and instead is a criminal activity that OCGs are more likely to invest in. Costs included the recruitment of former or current Pemex employees. Their involvement reduced the risks associated with unsafe oil extraction (such as using their technical engineering knowledge to avoid accidents when taps were mounted into a pipeline). As stated by a former Pemex employee, 'this [pipeline tapping] requires high tech and significant experience … those who perform this activity either are or were Pemex employees … there are not many people in Mexico with this kind of knowledge and this is why they are very valued and desired [by OCGs]'[80]. Expert drillers charged up to USD 6,000 per tap installed. The individuals associated with Pemex used their knowledge of Pemex's pipeline detection systems to circumvent these, reducing the risk of apprehension during extraction.

Rewards

Once an IPT was installed, oil thieves could fill a 10,000-litre container in ten minutes. Average prices on the black market ranged from USD 0.6 to USD 0.8 per litre, equating to the extraction of USD 36,000 to USD 48,000 of oil per hour. The average hourly wage in Mexico is USD 2.60, hence the rewards to be gained by these illegal means can be high. In 2019, the Mexican government's measures to counter TROP resulted in the scarcity of gasoline at gas stations, which in turn increased the black market prices for refined oil to USD 2.11 per litre in some states[81]. In Puebla state, where there were 1,815 IPTs in 2018, if each illegal tap extracted refined oil for only ten minutes, this would produce an oil stock worth USD 1.5 M on the black market. Stolen oil was easy for OCGs to sell, because of its high commercial and domestic use, and most usually to local markets rather than transported for sale across state or international borders.

Efforts and excuses

Most pipelines were located in remote areas, requiring effort to access them, and many were buried (albeit shallowly) underground and so required digging to gain access. These efforts were minimised by recruiting Pemex employees who were knowledgeable about pipeline locations, pipeline positioning above or below ground (and the depth below ground), and the scheduling of oil transported along pipelines. OCGs also found it easy to acquire weapons and the necessary communication devices required for their TROP and IPT activities.

Local community support to TROP was widespread and helped offenders in many ways[82]. 'In the past, your typical huachicoleros were small bands of grimy outlaws, largely harmless Robin Hoods who operated quietly and earned the goodwill of the people by handing out free buckets of gasoline and sponsoring parades and festivals in poor villages'[83]. In some areas of Mexico this has built a *huachicol culture*, that has included OCGs 'paying local musicians to write "corridos" that make apologies for the crime, that create a positive image of the huachicoleros and their lifestyle, and that contrast these with the government's incompetence'[84]. Oil thieves have even been given their own patron saint, 'El Santo Niño Huachicol, a kind of Christ-child depicted holding a siphon and a jerrycan'[85]. Additionally, individuals in local communities have benefited from being employed to perform roles associated with TROP and IPT, and received gifts, including healthcare. This has created

'excuses' for offenders active in TROP, with claims they perform a social and economic good by aiding communities in need. As one source noted, 'members of the OCG have carried out supposed "social actions" to earn the support of the [local] population'[86]. However, in some instances local communities have been threatened with violence if they did not co-operate. Involvement of local residents has included them acting as human shields, to prevent security forces from monitoring pipelines and seizing stolen oil or closing IPTs. This community support also helps to reduce efforts for oil thieves by keeping IPTs open for longer, avoiding the confiscation of stolen oil, and reducing the likelihood of apprehension.

Discussion

TROP via IPT in Mexico is a significant revenue generating activity for OCGs. The current study has illustrated how TROP via IPT operates within an opportunity structure that involves offenders exploiting vulnerabilities within a system, selling a high-demand and valuable product, and operating with a belief of avoiding apprehension and prosecution. Six key stages were identified within the commission of TROP via IPTs. A planning stage that involves obtaining information and equipment, and recruiting (or extorting) individuals to support the criminal activity; transportation to and from the extraction point, supported by lookouts who ensure safe passage; the installation of tapping equipment and extraction of oil, using oil pipeline flow scheduling information and technical expertise in mounting taps and valves; the storage of stolen oil in secure premises that are borrowed, commercially leased, or purchased, and; the disposal of stolen oil, primarily for revenue generating purposes.

The analysis identified the range of actors involved in TROP via IPT, and the organisation required for its successful commission. Although we do not go as far as naming individuals, the analysis provided a detailed account of the types of individuals and roles necessary for TROP via IPT. Additionally, although the analysis did not distinguish between OCGs, the location where these activities took place could be used to infer which OCGs were most likely to be responsible for TROP via IPT. For example, if an IPT was committed in the state of Tamaulipas, it was likely it was committed by the Los Zetas OCG because of the control they have in this state. The study has also shown the involvement of those outside the immediate criminal group, including individuals who provide information (e.g., oil pipeline flow scheduling), expertize (e.g., drilling into a pipeline and installing valves), and protection (e.g., lookouts to help guarantee safe passage while in transit). For any act of theft to be worthwhile, the items stolen must be of value and easy to dispose. The large volumes of oil stolen in Mexico via IPTs were mainly disposed of using a local network of sellers and users, including businesses, local communities and gasoline stations.

Stealing refined oil when the oil product is transferred along a pipeline requires relatively little investment. The transportation and storage of oil is, though, subject to licencing in Mexico. Gas stations are required to comply with licencing conditions established by Pemex, but when gas stations operate without regular checks, they provide a network that OCGs can exploit to support the disposal of stolen oil. Similarly, businesses whose outgoings involve high fuel costs can be attracted to the reduced prices of oil from a black market supplier. When the disposal of stolen products is easy and profitable, the process for acquiring these products can exploit the opportunities for their supply.

Table 2. SCP techniques and improvements in the use of deterrence for TROP via IPT in Mexico.

Crime script act	Intervention	SCP technique and deterrence improvements
Planning	Provide means for Pemex personnel to anonymously and securely report approaches by OCGs, or suspicions of employees' involvement with OCGs	Remove excuses – post instructions on procedures to follow
	Report arrests of Pemex employees to all Pemex employees	Increase risk and improve deterrence – reduce temptations of criminal involvement by increasing the perceived likelihood of being caught
Transportation to and from pipeline	Instal vehicle registration plate recognition cameras on routes close to pipelines to monitor vehicles (particularly those that fit the description of preferred vehicle models for TROP)	Increase risk – strengthen formal surveillance
	Targeted checkpoints and patrols on routes close to pipelines when oil is transported through pipelines	Increase risk – strengthen formal surveillance
	Instal signage on routes close to pipelines stating the presence of security cameras, and advertising random checks	Increase risk and improve deterrence – increase the perceived likelihood of being caught
Extraction	Steel coat the most vulnerable pipelines	Increase effort – make pipelines more difficult to drill
	Bury pipelines at a minimum of two metres below the ground in the most vulnerable locations	Increase effort – make pipelines more difficult to drill
	Remove signage stating 'Pemex duct' where a pipeline is buried.	Reduce rewards – conceal targets
	Use drones to fly along pipeline routes and instal signage stating the presence of drones, particularly along segments of pipelines that have experienced many IPTs	Increase risk and improve deterrence – strengthen formal surveillance and increase the perceived likelihood of being caught
Storage	Perform random checks of warehouses and confiscate oil that is stored in unlicensed facilities	Increase risk and reduce rewards – increase the risk of being caught, and deny benefits
	Conduct awareness campaigns targeted at warehouse owners near pipelines about the consequences of unlicensed oil storage	Reduce excuses and increase effort – alert conscience of OCG activity, and restrict access to facilities
	When storage facilities for stolen oil are identified, advertise to warehouse owners the penalties that were imposed	Improve deterrence and reduce rewards – increase the perceived likelihood of being caught, and deny benefits
Disposal	Perform inspections of gasoline stations and suspend licences if anomalies found in the amount of gasoline bought from Pemex and amount of gasoline sold.	Reduce rewards – disrupt markets for the sale of stolen oil
	Perform checks of oil-dependent industries, such as mining and transportation, that verifies invoices for oil supplied.	Reduce rewards – disrupt markets for the sale of stolen oil
	Conduct campaigns stating that buying stolen oil is a crime, is likely to be an inferior product, and generates violence	Remove excuses – alert consciousness to the impact of the illegal market
	Conduct money laundering investigations and freeze bank accounts	Reduce rewards – deny OCGs the benefits from selling stolen oil
	Publicly promote all confiscations of stolen oil, frozen bank accounts and arrests made that are associated with TROP	Increase risk and improve deterrence – increase the perceived likelihood of being caught

Currently, OCGs take advantage of several vulnerabilities within the system to make TROP via IPT a profitable venture. To counter the theft of a product requires crime commission to be made more difficult and less rewarding for the actors involved. Using the results from the current study we propose the use of situational crime prevention (SCP)[87] measures for countering TROP via IPTs. SCP focuses on countering the near

situational causes of crime. SCP techniques can make crime commission riskier, more of an effort and less rewarding, as well as removing excuses that influence decision-making (such as setting clearer rules) and reducing provocations towards criminal involvement (such as discouraging imitation).

Table 2 is ordered by the acts of the TROP via IPT crime script (with the acts of transportation to and from a pipeline combined), with descriptions of SCP interventions. Opportunities also exist to improve the use of deterrence for reducing TROP via IPT. Effective deterrence involves ensuring a perception of likelihood of arrest. To promote this perception, the existing and potential participants involved in TROP need to know what the threat is, and what will happen to them if caught. This requires effective advertising of the penalties. If the penalties or risk of penalties are unknown, they cannot deter. Even in situations where there are difficulties in effectively prosecuting individuals, effective advertising of penalties, threats, and criminal justice actions can contribute to crime reduction[88]. The SCP and deterrence opportunities listed in Table 2 are not exhaustive but illustrate alternatives for preventing TROP via IPTs. These include providing the means for Pemex personnel to anonymously report approaches by OCGs, informing Pemex employees of the arrests of work colleagues involvement in TROP (to increase the perceived likelihood of capture), removing 'Pemex duct' signage that indicates where a pipeline is buried, using drones to fly along vulnerable pipeline routes, installing signage on routes close to pipelines stating the presence of heightened security, performing random checks of warehouses and confiscating oil that is stored in unlicensed facilities, performing checks of oil-dependent industries (such as mining and transportation) that verifies invoices for the oil they have purchased, and targeting the infrastructure underlying money laundered from the proceeds of TROP. In practice, certain SCP or deterrence activities maybe more difficult to implement than others. For example, warehouse owners that store stolen oil may be less likely to cooperate with authorities when the consequence of doing so could be violence against them by OCGs.

< Table 2 about here >

Since 2019, the Mexican government has been more active in its strategy for reducing TROP and IPTs. The focus has been towards arresting people for their involvement, seizing property, disabling IPTs and freezing bank accounts of those involved in TROP. Each of these instances also can be used as a deterrent to TROP and IPTs with effective advertising of those who have been caught, the property seized, and the financial proceeds of crime that have been confiscated by the government. In 2019, Pemex improved their own processes and disabled over 13,000 IPTs but the large number of incidents suggests OCGs were still active in their attempts to steal oil. To better deter them from doing so, each tap disabled provides an opportunity for promoting the likelihood of taps being found and removed, and reducing the rewards from the criminal activity.

Limitations and future research

Data concerning TROP via IPTs from Pemex and government recording systems was limited, therefore OSINT were used. Triangulation using different open sources was conducted to address this limitation but use of semi-structured interviews with experts in academia, government and industry who are knowledgeable about TROP could have

improved this further. Time and funding restrictions prevented us from interviewing experts. The data used in the current study was extensive, but some details about TROP and IPTs may have been missed. Our analysis did not reveal significant differences in the activities performed by different OCGs in Mexico, but we encourage replication of our study to determine whether our results are generalisable. Additionally, we encourage future research to examine certain activities in more detail to identify specific information about the decisions made by participants. This could include examining what led associates from Pemex to become involved in TROP with an OCG, and how they provided information about pipelines. Future qualitative research using interviews with offenders could also improve our understanding of the risks, costs and benefits associated with TROP that affects their decision-making.

In methodological terms, we highlight that crime scripts focus on the specifics and mechanics of the criminal process and do not attempt to inform broader motivations for criminal involvement or socio-economic conditions that influence criminal activity. We do, though, recognise that TROP can be prevalent in impoverished communities where the supply of oil below market value can be attractive. Community support for OCGs engaged in TROP is evident. Local community perspectives on TROP, the social support enabling it, and the influence of socio-economic drivers that lead ordinary Mexicans to support oil thieves is an area of potential research.

Lastly, even though opportunities for reducing TROP via IPT using situational measures and improving the use of deterrence are apparent, offenders are quick to adapt to interventions that restrict their activities. If at some point implemented, the prevention measures proposed in this study should be evaluated for their effectiveness.

Conclusion

TROP is a high revenue generating activity for criminal groups. Using crime script analysis, the research revealed that those engaged in TROP via IPTs in Mexico operate within an opportunity structure for this crime commission, with a degree of ease, motivated by the high rewards and low risks of being caught. TROP via IPTs in Mexico involves individuals from OCGs playing particular roles, and support activities from others who are either recruited, extorted, or bribed for their involvement, knowledge, and technical expertise. The study has also illustrated how crime script analysis can be used as a tool for deconstructing a clandestine and complex criminal activity.

To date, most attempts to reduce TROP and IPTs have relied on arresting and prosecuting those involved. Although these approaches have offered some dividends, TROP and IPT continues to be an issue in Mexico (and other parts of the world). When opportunities exist for criminal groups to exploit vulnerabilities within a system, where the risks associated with criminal activity are low, and efforts to do so are outweighed by the rewards from these activities, the criminal activity is likely to prevail. Settings in which TROP prevails requires an understanding of a combination of the situational circumstances and wider socio-economic conditions that makes this activity prevalent. SCP interventions and improvements in the use of deterrence offer viable solutions for reducing the theft of refined oil products by making this criminal activity more difficult to commit, less rewarding, and improve the perceived likelihood of apprehension if an individual considers becoming involved in TROP.

Notes

1. Refined oil products, such as gasoline and diesel, are produced from the refining oil and natural gas. Secretaría de Energía (SENER), Qué son los petrolíferos?
2. Ralby, 'Downstream Oil Theft'.
3. Aqrawi-Whitcomb et al., 'Dangerous Black Markets.'
4. Beittel, Mexico: Organised Crime.
5. Pemex, Reservas de Hidrocarburos.
6. See note 2 above.
7. Pemex, Tomas Clandestinas en 2018.
8. Mexico's Federal Law Against Organised Crime states that an individual can be considered a member of an OCG when three or more individuals organise to perform, in a permanent or reiterated manner, a conduct that – by itself or together with other(s) – intends to commit one or more of the crimes described in the first section of this law.
9. Sáinz, 'Las bandas del huachicol'.
10. Based on an average per barrel oil price of USD 69.78 in 2018 (OPEC, 2019).
11. Presidencia de la República, Conferencia de prensa.
12. See note 2
13. See note 3
14. CISLAC, Policy Brief on Oil Theft.
15. Ufuoma and Omoruyi, 'Crude Oil Theft'.
16. Ikelegbe, 'Economy of Conflict'.
17. Goi, 'Combating Fuel Theft?'
18. Arias and Maldonado, 'FARC Terrorism in Colombia: A Clustering Analysis'.
19. Durango-Cordero et al., ' Accidental Oil Spills'; Finer et al., 'Oil and gas projects'.
20. See note 17 above.
21. Calderón et al., 'Violence in Mexico'; Grillo, 'Diversification;' Guerrero-Gutiérrez, 'Security, Drugs, and Violence'.
22. Guerrero-Gutiérrez, 'Security, Drugs, and Violence'
23. Rainsford, 'Control of Avocado Business'; Wainwright, 'Narconomics'.
24. Harp, 'Blood and Oil'.
25. Ralby, Downstream Oil Theft; Guerrero-Gutiérrez, 'Security, Drugs, and Violence'.
26. Etellekt Consultores, Robo de Hidrocarburos en México 2016.
27. See note 2
28. Pemex was created by the nationalisation and expropriation of all private, foreign, and domestic oil companies. An Energy Reform programme agreed by the Mexican government allowed private participation in the petroleum products supply chain from 2016.
29. Illegal pipeline taps are defined by Mexico's Federal Law to Prevent and Sanction Crimes concerning Hydrocarbons as any alteration to a pipeline with the purpose to extract hydrocarbons, refined oil products or petrochemicals.
30. See note 26 above.
31. Pemex, 'Reporte De Tomas Clandestinas 2018'.
32. Loredo, 'Tomas clandestinas de Pemex.'
33. Moreno, 'Robo de combustible.'
34. Santos, 'De 14 mil detenidos por huachicol.'
35. PROFEPA, 'Estudio de suelo realizado'; Pemex, Informe de Sustentabilidad 2017.
36. Finer et al., 'Oil and gas projects'; Durango-Cordero et al., 'Accidental Oil Spills'; Ikelegbe, 'Economy of Conflict'; Ufuoma and Omoruyi, ' Crude Oil Theft'; Jernelöv, 'Threats from Oil Spills'.
37. PROFEPA, 'Estudio de suelo realizado'.
38. Semple, 'Victory Over Fuel Thieves'.
39. Cornish and Clarke, 'Rational choice perspective'
40. Leclerc and Wortley, 'The Reasoning Criminal'.
41. See note 39 above.

42. Cohen and Felson, 'Crime Rate Trends'; Eck and Weisburd, 'Crime Places.'
43. Kennedy, 'Deterrence and crime prevention'.
44. Ibid.
45. UDLAP, 'Global Impunity Index'.
46. Transparency International, 'Corruption Perceptions Index'
47. Cornish, 'The Procedural Analysis of Offending'
48. Ibid.
49. Ibid.
50. Chiu et al., 'Drug Manufacturing'; Jaques and Bernasco, 'Drug dealing'; Lord et al., 'Counterfeit Alcohol'.
51. Brayley et al., 'Child Sex Trafficking'.
52. Leclerc et al., 'Sex offenders'.
53. Hiropoulos et al., 'Terrorism financing'.
54. Dehghanniri and Borrion(2019)provide a systematic review of research using CSA.
55. Leclerc et al., 'Sex offenders'; Chiu et al., 'Drug manufacturing'; Tompson and Chainey 'Data Collection and Analytical Strategy'; Clarke and Newman, Outsmarting the Terrorists; Hancock and Laycock, 'Organised crime and crime scripts'.
56. Chainey, 'Methodical process for populating a crime script'. We report in a complementary article on a methodological approach to crime script analysis that describes in full the data collection process we used: https://osf.io/mpdty/?view_only=34e15f7c18014a0299fb94bae656973d
57. See note 47 above.
58. Tompson and Chainey 'Data collection and analytical strategy'.
59. Dehghanniri and Borrion, 'Crime scripting: Systematic review'.
60. See note 58 above.
61. https://www.pemex.com/acerca/informes_publicaciones/Paginas/tomas-clandestinas.aspx Pemex operate over 95% of pipelines in Mexico. Data from private companies that operate the remaining 5% was not available.
62. Such as https://theodora.com/pipelines/mexico_pipelines.html#map.
63. Bowen, 'Document Analysis'.
64. Gross, 'Document Analysis'.
65. Scott, A Matter of Record.
66. See note 64 above.
67. See note 56 above.
68. See note 56 above.
69. .Vieira, 'El robo de combustible'.
70. Salazar, 'La Negra'.
71. CartoCrítica, 'Tomas clandestinas'.
72. González, 'En un año se blanquearon 10 mmdp'.
73. See note 24.
74. The Mexican Energy Regulator Committee is responsible for issuing licences for the transporting, storage, and sale of hydrocarbons, petrochemicals and oil.
75. See note 45 above.
76. Illegal pipeline tapping is punishable by up to 30 years in prison.
77. See note 24 above.
78. ViceNews, 'Mexican Oil and Drug Cartels'.
79. Ibid.
80. Rincón, 'Robo de gasolina'.
81. Ramos, 'Mercado negro de gasolinas'.
82. CESOP, Robo de Combustible.
83. See note 24 above.
84. Meza, 'Huachicoleros'.
85. See note 24 above.
86. Alzaga, 'Con "El Toñín"'.

87. Clarke, 'Situational crime prevention'.
88. See note 43 above.

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