Seasonality of incident types in transport crime - Analysis of TAPA statistics

Journal of Transportation Security
https://doi.org/10.1007/s12198-022-00254-w

Seasonality of incident types in transport crime – Analysis of TAPA statistics

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Received: 23 February 2022 / Accepted: 5 September 2022

Abstract

This paper examines weekly and annual seasonality in incident categories to find patterns and trends in transport crime globally, concerning the value of stolen goods, incident frequency and incident category. Secondary data is utilized to analyse a contemporary challenge in logistics and supply chain research, namely theft and robbery of goods during shipment. The research is based on the TAPA global IIS transport-related crime database. Incident frequencies and mean values are analysed primarily with chi-square tests and analyses of variance (ANOVAs). The results are analysed and discussed within a frame of reference consisting of theories from logistics and criminology. The main conclusion is that there is an annual as well as a weekly seasonality of most incident categories, but the patterns vary among incident categories. The results are primarily limited by the content and classification within the TAPA IIS database.

Keywords Supply chain risk · Antagonistic threats · Transport · Value of stolen cargo · Cargo theft incident categories

Introduction

The theft of goods poses a significant problem across the globe. The European Union (EU) estimates cargo theft at €8.2 billion annually, which, in the context of all transport, is an average of €6.72 per trip (EP 2007). According to Boone et al.

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Published online: 14 September 2022

(2016) is cargo theft estimated to cost companies $10B annually (in the U.S.) and $30B worldwide. Furthermore, Boone et al. (2016) stresses that the vast majority of the incidents occurs under the transport part of the supply chain. These numbers, like most figures on cargo theft, are conservative, primarily because of two reasons; namely, underreporting of actual theft, and if reported, only the direct loss is stated (value of the stolen items, sales, or invoice value). The theft of cargo and cargo carriers is an old and more or less constant business risk that has always been a part of the overall business risk portfolio. Within the understanding that the problem of cargo theft will be very difficult to eradicate, as it always has been around the flow of goods globally, it is important to understand the current form of the problem. Therefore, there will always be a need for new research within this field. According to an industry report (TT Club 2022) trends are changing as they point out port congestion, insider threat and weak spots in digitalisation around freight services as increasing problem areas. Furthermore, the report stresses the also the changes in supplier location and mode shifts in transports as linked to increased problems with cargo theft.

The current understanding of risks and uncertainties within global supply chains stems from the area of supply chain risk and resilience research following 9/11 2001. Sheffi (2001) points out the effects of the World Trade Centre terrorist attacks on the global flow of goods. The effects may be indirect but was devastating, nevertheless. This event and non-antagonistic events such as the Hurricane Katrina and other natural disasters demonstrated the power to disrupt or cause uncertainty in supply chains (Elliott 2005; Peck and Juttner 2002). The increase in cargo theft means that if has become a global problem which primarily leads to the effects, financial losses and disruptions in supply chain operations (Liang et al. 2022). The impact is stated to be up to six times the value of the stolen products because of costs of product replacement, accident handling, increased insurance premium, loss of sales, and negative impact on the business reputation (Burges 2022).

The research concerning risks in a supply chain is fairly new and it started with risks and purchases (Khan and Bernard 2007). Since then, several authors have addressed the relationship between risk and supply chains (Robinson et al. 1967; Burnes and Dale 1998; Burnes and New 1996; Cousins et al. 2004; Hood and Young 2005; March and Shapira 1987; Johnson and Haug 2021; Alora and Barua 2022; Ekwall and Lantz 2021). Studies of supply chain risks seldom address specific causes of risk (Christopher and Lee 2004; Christopher and Peck 2004; Juttner 2005; and Sheffi 2001). They simply mention supply chain risk sources without discussing causes such as theft, smuggling, sabotage, and criminal activity. Even within these four areas, the causes need to be understood in more detail as the variety in modus operandi, expected outcome from the perpetrators' point of view and presented security features all affect the actual events. This leads to a more detailed understanding of each risk source, from a supply chain perspective, is needed.

Linked to the area of supply chain risk, one can talk about the vulnerability of supply chains. Within this field, cargo theft is one of the main 'unwanted effects', which represents the root causes of supply chain disruptions (Waters 2007; Ekwall and Lantz 2016; Justus et al. 2018; Nagurney et al. 2018). Juttner (2005) defines supply chain vulnerability as 'an exposure to serious disturbance arising from

supply chain risks and affecting the supply chain's ability to effectively serve the end customer market'. This definition opens up to the understanding that different geographical locations, as well as other business aspects, lead to differences in the actual business risk, this follows the stress of risk factors in cargo theft (Liang et al. 2022).

In the EU, the majority of freight transport takes place on the road, this leads to that road-related cargo theft incidents thereby can be considered a threat against one of the core principles for the EU, namely the free movement of goods (Europol 2009). There is an estimation of losses due to cargo theft, both globally and in different regions, and most of these numbers are, at best, unreliable. These figures are calculated extraordinarily conservatively since most cargo theft goes unreported, and these figures reflect only the value of the items, hence, disregarding indirect losses from, for example, production downtime due to lack of components. (Barth and White 1998). There are predictions that the real figures for cargo theft are either grossly underestimated or overestimated in official reports (Gips 2006). Gathering accurate numbers for cargo theft losses is difficult or impossible in many cases, due to limited reporting by the transport industry and the lack of a national law enforcement system requiring reporting and tracking uniformity (ECMT 2001).

Statistics on cargo theft indicate patterns and trends that compose a broad picture of the many differences in the occurrence of cargo theft. About 41% of all incidents occur during the driving phase of transportation (EP 2007). In 15% of incidents, the truck is stolen along with the goods. Another 15% represents hijacking and robbery (EP 2007). According to a report by the International Road Transport Union (IRU) (2008), trucks and their loads were targeted in 63% of all thefts, while 43% were either direct thefts of transported goods or included the theft of the drivers' personal belongings. Of these thefts, 42% occurred in truck parking lots and a further 19% on motorways (IRU 2008). This implies that 61% of all thefts occurred at a temporary rest area along a road. Cargo theft typically occurs in trucks that are temporarily parked along the road, often waiting for loading and unloading opportunities (EP 2007; TruckPol 2007; IRU 2008). In this context, prior research shows that a violent modus operandi has a greater impact in terms of the value of stolen goods (Ekwall and Lantz 2013, 2015a, b, 2016; Justus et al. 2018; Nagurney et al. 2018; Lorenc and Kuznar 2018).

This paper addresses a limited array of risks and uncertainties that are defined as antagonistic threats. According to Ekwall (2009), antagonistic threats can be defined as "*deliberately caused illegal and hostile threats against the planned or wanted logistics process, function, and structure*". Based on this definition, the core element for antagonistic threats is motivated perpetrators with hostile intentions toward the object and/or third party that violate any international, country, or local law. The antagonistic threat is therefore a crime and can be understood with the use of theories from criminology, or the scientific study of crime in combination with logistics theories.

According to Liang et al. (2022), there are 22 different risk factors linked to cargo theft, of these can 11 be stated as having risk factor 1, on a scale from 1 to 9. The top 6 factors, having a risk factor from 5 to 8 are (in falling order); Cargo type (8), Location type (8), Geographical region (7), Transportation mode (7), Seasonality

(6) and Security level (5). All together, these six risk factors stand for about 63% of the total risk. In this paper, we focus on Seasonality (value, mean value and frequency) both for week (day of the week) and annually (month) linked to reported incident categories. With the purpose to explore weekly and annual seasonality of incident categories in cargo crime in order to find patterns and trends that can be used to mitigate cargo theft, this paper uses an interdisciplinary exchange of views, ideas, and theories which is needed to develop as an applied science (Klaus et al. 1993; Stock 1997). This is achieved by forming the framework model consisting of theories from both logistics and criminology and within this model utilizes the secondary data provided by the TAPA global IIS database to find patterns and trends in cargo theft within the three regions of TAPA, namely EMEA, Asia–Pacific and Americas. This study follows the quantitative analysis tradition in risk management (Behzadi et al. 2018; Ionita et al. 2018) by addressing an operational problem (Leone and Porretta 2018; Lewis 2003; Skorna and Bode 2011).

Frame of reference

According to Christopher (2005), supply chains are defined as '*The network of organisations that are involved through upstream and downstream relationships in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer'*. This shall be compared with the definition of logistics. *'The process of strategically managing the procurement, movement and storage of material, parts and finished inventory (and the related information flow) through the organization and its marketing channels in such a way that current and future profitability are maximized through the cost-effective fulfilment of orders'* (Christopher 2005). The two definitions work together to fulfil the scope of logistics, which aims to provide the right product at the right time and the right place (Christopher 1998), by alignment of all activities from the supplier to the end customer. The purpose of the transport network is to physically move the goods within a certain supply chain to fulfil the scope of logistics. An integrated supply chain is normally modelled with different building blocks, which can be located throughout the world and connected through a transport network (Gibson et al. 2005). The transport network will need geographical fixed constructions and infrastructure to fulfil the scope of logistics (cf Christopher 2005). The cargo thief aims to remove goods from the goods flow by attacking the movement of resources and/or the infrastructure it uses. A popular statement here is that the weakest link (offers the best theft opportunity) also is the most utilized attack point in the supply chain (Jażdżewska-Gutta and Borkowski 2022). A potential perpetrator can also utilize the information flow to better plan the theft of goods or commit fraud which targets the flow of capital.

There are several different risks attached to transport activities within the supply chain, one of which is the risk of product theft, primarily during road transport (Ekwall and Lantz 2013; Skorna and Bode 2011; Lorenc and Kuznar 2018). Cargo thieves attempt to remove goods (products) from a supply chain by using different methods to attack different transport chain locations (Farrell 2015). All location

types can, for short periods, be considered geographically fixed. For example, vehicles (*En route*) are moveable; however, this movement is predictable in place, yet less predictable in time. Within Supply Chain Management (SCM), it is common to discuss risk and reward sharing is a key component (Mentzer et al. 2001). This implies that a full understanding of the different supply chain risks is needed to reduce the ripple effects of all magnitudes. It also stresses the need for interdisciplinary research, because risk management practices are included in SCM (Sanders and Wagner 2011).

Criminology distinguishes three elements of a crime that are present in all sorts of crime ranging from occasional violence to advance and complex economic crimes (Sarnecki 2003; Sherman et al. 1989; Sampson et al. 2010). The elements are:

1. Motivated perpetrator
2. Target (goods and equipment)
3. Location (the place where perpetrator and target meet)

Motivated perpetrator The perpetrator is an individual that, based on the outcome of the decision process, commits a certain action or prepares for a certain action that is prohibited by a locality or country of international law. The perpetrator's behaviour can be modelled as acting rationally on the margin or limited (by circumstance, choice or mixture of both) rational choice.

Target The desirable outcomes or targets for the motivated perpetrator differ greatly depending on the motivated perpetrator's decision process. Normally is it suitable to describe the target as the primary or direct reason for the action, but also as secondary or indirect reasons. The primary targets can be shipped products, resources used, and infrastructure for normal property crimes.

Location The location or place where the motivated perpetrator and the target meet. The characteristics of the location include different security measures or crime preventive features directly linked to the location. A good example of this is CCTV surveillance of areas may lead to a relocation of the crime instead of prevention of it (Weisburd et al. 2006; Waples and Gill 2006; Tilley 1993).

The theory of elements of crime states that a crime only occurs when all three elements come together at the same time/place. This means that if one of the three elements is missing then is crime impossible. Any combination of location and target is normally referred to as a crime opportunity. According to Clarke and Cornish (2003) are both motivated perpetrators and a crime opportunity is needed for a crime to occur.

Crime opportunities depend on routines or predictability within certain boundaries. This statement also includes more principles than the original, implying that system predictability or routine provides crime opportunities. This is the routine activity theory (RAT) in criminology (Cohen and Felson 1979). This theory

provides a strong theoretical foundation for understanding crime and opportunities for crime. RAT argues that normal movement and other routine activities play a significant role in potential crime (Roncek and Maier 1991; Mustaine and Tewksbury 1998; Smith et al. 2000; and Sherman et al. 1989). A key understanding with RAT is that potential perpetrators may seek locations where their victims or targets are numerous, available, convenient, and/or vulnerable (i.e., lack security features, from the perpetrator point-of-view). Felson (1987) uses the illustration of "*how lions look for deer near their watering hole*" to explain the practical relevance of RAT.

RAT states that predictability in infrastructure and resource movement will significantly contribute to establishing crime opportunities. The flow of material varies to a higher extent but depends on the actors within the supply chain. Therefore, it is possible to predict the flow of goods to some extent. RAT provides a theoretical foundation regarding antagonistic threats against the transport. Thus, when the transport network changes, so do the theft opportunity.

The different theft opportunities can be exploited in different ways. Within criminology, it is common to, based on how a theft opportunity was exploited, classify it into either modus operandi or incident categories. Modus operandi (MO) can simply be described as one´s habit of work or mode of operating and is often used in criminology and police work to describe perpetrators way of committing a specific crime. The term incident category is an overlapping term but shift the focus from a grouping of individual perpetrators MO towards the combination of location and MO.

According to Kroneberg et al. (2010), actors often *'stick to a particular action alternative in an automatic-spontaneous mode of decision making, which leaves aside other alternatives and incentives*. The only common characteristic across all parts of the supply chain, including the transport network, is the perpetrator's choice of whether, where, when, and how to commit the cargo theft. Based on the 'opportunity' theories of crime, namely RAT, crime pattern theory, and the rational choice perspective, the seasonality in crimes can be viewed differently. According to the RAT, crime opportunities are concentrated in time and place concerning the three elements of crime. This implies that changes in any one of these three elements can influence seasonality differently. According to Hylleberg (1995), exogenous causes of crime are important for understanding seasonality. These causes are *calendar events*, *weather*, and *time of year*, which can all increase or decrease criminal behaviour depending on the local contextual surrounding. The *time of year* can affect crime opportunities in several different ways, for example, the Christmas shopping season. In short, seasonality in crimes may be influenced by the *time of year* depending on the number of available targets and potential customers for stolen goods. It can also be found in *calendar events* such as day of the week for similar reasons; however, in that case, it largely depends on the number of available targets. Furthermore, there will be differences in seasonality for different incident categories as crime opportunities differ across incident categories.

The flipside of the RAT is that crime can be predicted, so-called crime forecasting (Gorr et al. 2003), a technique police forces can use to recognize expected hot spots and criminality at certain places (Langworthy and Jefferis 2000). The main

limitation in crime forecasting is the reliability, especially where small samples are used (Gorr et al. 2003).

Based on the above framework, the following research hypotheses may be formulated:

H1: There are annual seasonality patterns for different incident types in cargo theft
H2: There are weekly seasonality patterns for different incident types in cargo theft

These two hypotheses fall within the majority of the top six risk factors of cargo theft (cf. Liang et al. 2022) but stresses the seasonality factor a little more. The focus on seasonality in cargo theft can be found in other research (Justus et al. 2018; Ekwall and Lantz 2013, 2015a, b).

Method

All data utilized in this paper is secondary data. According to Rabinovich and Cheon (2011), the use of secondary data analysis is overlooked in logistics research and should be used to address contemporary challenges in logistics and supply chain research. The database analysed in this paper is the TAPA EMEA Incident Information Service, IIS, which contains about 27,000 unique reported incidents of crimes against road transport operations globally during the years 2000–2022. Hence, the TAPA IIS data must be assumed to provide the most representative image of the true occurrence of cargo theft incidents.

The research presented in this paper follows the tradition from criminology research about time and place for crime presented by Brantingham and Brantingham (1981), where the three levels are macro-, meso- and microlevel. According to this classification is this research is macro-oriented where the analysis is focusing on the global level, as well as on the different TAPA regions level, and the sampling is multistate. The usefulness of this tripartite classification is that any empirical analysis of crime can focus on one or more of these spatial levels of analysis. Normally is research in criminology a mixture of levels and the different levels serve as a reminder for the researchers for greater understanding about the aetiology of crime (causes), in another word, that crime is contextual depended (Barclay and Donnermeyer 2009).

The different categories are analysed concerning weekly and annual seasonality. We describe and analyse incident values and frequencies with appropriate statistics. Comparisons of mean values are conducted with one-way ANOVA if Levene's test does not reveal significant heteroscedasticity, and with the Brown-Forsythe test otherwise. If the ANOVA or Brown-Forsythe test is rejected, post hoc analysis is conducted with pairwise t-tests with Bonferroni correction. Comparisons of frequencies are conducted with chi-square tests. If the overall

chi-square test is rejected, post hoc analysis is conducted with pairwise chi-square tests with Bonferroni correction.

The TAPA EMEA IIS database

The TAPA IIS databases comprise approximately 57,000 individual reported incidents of road transport crimes committed between 2009–2022 (EMEA and APAC) and 2015–2022 (Americas). The global TAPA structure is based on the aforementioned three regions (the Americas, EMEA, and APAC), each of which has its IIS database. The crime statistics in the TAPA IIS database are prepared by TAPA members and various law enforcement agencies (LEAs). The identities of the companies involved, directly and indirectly, are not disclosed in the reports, to avoid negative publicity and ensure better data reliability. Further, the reporting entity determines the extent of disclosure of the incident details, thus suggesting that the quality of data varies across incidents and countries.

Reports on the database are generally created using the online reporting interface on the website www.tapaemea.com. The reports include several mandatory facts, such as the details of the reporter (name and contact details), incident date, and description. Further, there are several fixed descriptions about the incident in the following categories: incident type, modus operandi, product type, type of location, country of occurrence, and product and loss value in euros. It is also possible to add additional data to the report. In this paper, we use the stated loss, in Euros, in the database. If a report lacks one of the points we are analysing for, that report is considered incomplete and not included in the final analysis. This means that there are more reports in the TAPA IIS database for the included years than we are utilizing in this paper.

Typology road-related cargo theft

This paper uses the same definition for different road-related cargo theft that is used by TAPA IIS. For an incident to be qualified to be reported, the expected loss needs to be greater than 1000 Euro.

Hijacking - occasions, where force, violence or threats are used against a driver and the vehicle/goods, is stolen. Hijack includes a forced stop of a vehicle.
Robbery - occasions, where force, violence or threats are used against humans and the vehicle/goods, is stolen. Robbery does not include a forced stop of a vehicle.
Theft of – ***Vehicle, Container or Trailer*** - where an unattended vehicle and/or Container and/or trailer are stolen with the load.
Theft from – ***Container, Facility, Trailer, Train or Vehicles*** - thefts of load from stationary vehicles, containers, trains, trailers or from a facility. Theft from unattended delivery vehicles is included here.

Fraud - occasions, where intentional deceptions are used against humans and the vehicle/goods, is stolen.
Truck Theft - Theft of empty truck.
Clandestine - secretly added cargo to a shipment. This can be stowaway, illegal products etc.

Results

Table 1 and Fig. 1 describes the observed total incident value for all combinations of month and incident category in EMEA while Fig. 1 describes the total incident value for the different incident categories in EMEA. As one might have expected, there are large differences between months for many of the incident categories. Hence, a deeper analysis is needed.

Table 2 and Fig. 2 displays the frequencies for all combinations of month and incident categories in EMEA. *Clandestine*, *Hijacking*, *Theft from Container*, *Theft from Train*, *Theft of Container*, and *Theft of Trailer* are not characterized by significant differences between months in incident frequency. *Fraud* is characterized by a significant monthly difference in incident frequency ($\chi 2 = 25.7$, $p = 0.007$), but post hoc analysis does not reveal any significant pairwise differences between months. *Robbery* is characterized by a significant monthly difference in incident frequency ($\chi 2 = 31.1$, $p = 0.001$). Post hoc analysis shows that the *Robbery* frequency is significantly lower in July than in October.

Theft is characterized by a significant monthly difference in incident frequency ($\chi 2 = 467.9$, $p < 0.001$). Post hoc analysis shows that the *Theft* frequency is significantly lower in July and August than in all other months but June, September, and December. *Theft* frequency is also significantly lower in June and September than in January, February, March, April, May, October, and November. In addition, *Theft* frequency is significantly lower in December than in January, February, March, and November. Furthermore, *Theft* frequency is significantly lower in April than in January, February, and March. Finally, *Theft* frequency is significantly lower in May, October, and November than in January and February.

Theft from Facility is characterized by a significant monthly difference in incident frequency ($\chi 2 = 28.0$, $p = 0.008$), but post hoc analysis does not reveal any significant pairwise differences between months. *Theft from Trailer* is characterized by a significant monthly difference in incident frequency ($\chi 2 = 45.9$, $p < 0.001$). Post hoc analysis shows that the *Theft from Trailer* frequency is significantly lower in June than in January, February, and October.

Theft from Vehicle is characterized by a significant monthly difference in incident frequency ($\chi 2 = 642.3$, $p < 0.001$). Post hoc analysis shows that the *Theft from Vehicle* frequency is significantly lower in May, June, July, and August than in all other months but April. In addition, the *Theft from Vehicle* frequency is significantly lower in March, April, September, and December than in January, February, and November. Finally, the *Theft from Vehicle* frequency is significantly lower in October than in January and November.

Table 1 Total values (in thousands of EUR) for all combinations of month and incident category in EMEA

Month	1	2	3	4	5	6	7	8	9	10	11	12
Clandestine	2	0	81	0	53	0	104	661	2	0	106	5
Fraud	6053	5013	7394	6123	3440	5360	4155	5218	12,297	5870	4607	5218
Hijacking	8958	2295	10,440	5501	6926	10,230	6811	12,513	2687	14,452	5289	6061
Robbery	1810	2660	7360	4201	57,457	2459	2919	10,738	2360	3550	4432	6118
Theft	8886	12,228	16,568	14,586	6669	5284	7901	4942	3569	5710	7030	3016
Theft from Container	270	609	670	1241	779	536	920	2661	422	944	539	198
Theft from Facility	34,435	12,694	10,219	18,007	23,019	16,055	33,143	26,652	12,406	13,557	11,015	20,049
Theft from Trailer	2997	3264	4689	2959	2104	3937	2522	3524	3169	3946	3595	2948
Theft from Train	1	0	60	13	100	136	0	113	155	6	0	0
Theft from Vehicle	49,352	42,124	40,208	33,576	26,801	29,216	31,941	26,476	39,275	42,272	49,695	37,154
Theft of Container	123	356	158	91	964	325	1116	107	95	227	2	3185
Theft of Trailer	9007	3727	5283	3793	7234	3799	2394	1822	1844	1487	10,658	4150
Theft of Vehicle	9037	11,462	17,856	7500	8147	23,541	7883	10,602	9789	12,972	11,411	7835
Truck Theft	2848	2172	2170	6821	1073	1546	1708	1370	1003	462	836	1006

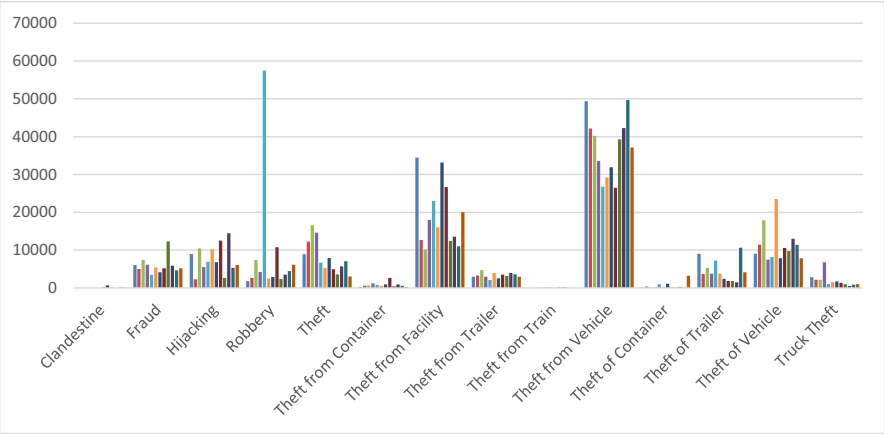

Fig. 1 Total values (in thousands of EUR) for all combinations of month and incident category in EMEA

Theft of Vehicle is characterized by a significant monthly difference in incident frequency ($\chi 2 = 159.7$, $p < 0.001$). Post hoc analysis shows that the *Theft of Vehicle* frequency is significantly lower in June and July than in January, February, November, and December. In addition, the *Theft of Vehicle* frequency is significantly lower in April, May, and September than in November and December. Finally, the *Theft of Vehicle* frequency is significantly lower in March, August, and October than in December.

Truck Theft is characterized by a significant monthly difference in incident frequency ($\chi 2 = 243.0$, $p < 0.001$). Post hoc analysis shows that the *Truck Theft* frequency is significantly lower in November and December than in January, February, March, and June. In addition, the *Truck Theft* frequency is significantly lower in April, July, August, September, and October than in January, February, and March. Finally, the *Truck Theft* frequency is significantly lower in May and June than in January.

Table 3 and Fig. 3 describes the observed mean incident value for all combinations of month and incident category in EMEA while Fig. 3 describes the mean incident value for the different incident categories in EMEA. *Clandestine*, *Hijacking*, *Robbery*, *Theft*, *Theft from Facility*, *Theft from Trailer*, *Theft from Train*, *Theft from Vehicle*, *Theft of Container*, *Theft of Trailer*, *Theft of Vehicle*, and *Truck Theft* are not characterized by significant differences between months in mean incident value.

Fraud is characterized by a significant monthly difference in mean incident value ($F = 3.0$, $p < 0.001$). Post hoc analysis shows that the *Fraud* mean incident value in September is significantly higher than in all other months but October.

Theft from Container is characterized by a significant monthly difference in mean incident value ($F = 2.4$, $p = 0.011$). Post hoc analysis shows that the *Theft from Container* means incident value in August is significantly higher than in all other months but March, June, and July.

Table 2 Frequencies for all combinations of month and incident category in EMEA

Month	1	2	3	4	5	6	7	8	9	10	11	12	Total
Clandestine	2	0	2	0	1	1	3	3	1	0	2	1	16
Fraud	86	83	82	73	68	73	65	64	44	49	70	74	831
Hijacking	26	22	35	27	31	25	28	29	23	29	30	21	326
Robbery	26	20	17	14	17	19	9	16	13	36	28	25	240
Theft	401	351	254	170	216	140	107	106	131	218	242	151	2487
Theft from Container	7	15	7	15	15	5	9	7	7	11	10	10	118
Theft from Facility	127	107	83	91	108	91	95	106	109	112	141	121	1291
Theft from Trailer	73	77	65	43	59	30	43	50	57	77	58	40	672
Theft from Train	1	0	3	3	2	2	0	2	2	1	0	0	16
Theft from Vehicle	1573	1470	1209	1063	935	924	839	903	1221	1299	1593	1150	14,179
Theft of Container	4	3	2	3	5	1	2	1	2	3	2	6	34
Theft of Trailer	24	26	19	25	35	24	20	22	18	20	35	31	299
Theft of Vehicle	179	183	149	115	126	100	102	136	121	140	209	255	1815
Truck Theft	141	99	96	46	50	67	37	41	45	33	21	26	702
Total	2670	2456	2023	1688	1668	1502	1359	1486	1794	2028	2441	1911	23,026

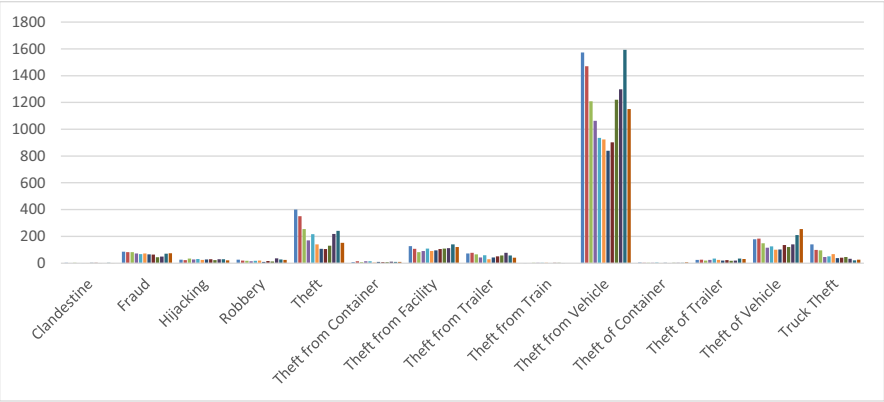

Fig. 2 Frequencies for all incident categories in EMEA

Table 4 and Fig. 4 describes the observed total incident value for all combinations of the day of the week and incident category in EMEA. As one might have expected, there are large differences between months for many of the incident categories. Hence, a deeper analysis is needed.

In Table 5 and Fig. 5, the frequencies for all combinations of the day of the week and incident category in EMEA are displayed. *Clandestine*, *Theft from Container*, *Theft from Train*, *Theft from Facility Theft of Container*, *Theft of Trailer*, *Theft of Vehicle*, and *Truck Theft* are not characterized by significant differences between days of the week in incident frequency.

Fraud is characterized by a significant day of the week difference in incident frequency ($\chi 2 = 140.3$, $p < 0.001$). Post hoc analysis shows that the *Fraud* frequency is significantly lower on Saturdays and Sundays than on all other days of the week.

Hijacking is characterized by a significant day of the week difference in incident frequency ($\chi 2 = 39.4$, $p < 0.001$). Post hoc analysis shows that the *Hijacking* frequency is significantly lower on Saturdays than on all other days of the week but Sundays, and significantly lower on Sundays than on all other days of the week but Fridays and Saturdays.

Robbery is characterized by a significant day of the week difference in incident frequency ($\chi 2 = 34.5$, $p < 0.001$). Post hoc analysis shows that the *Robbery* frequency is significantly lower on Saturdays than on all other days of the week but Sundays, and significantly lower on Sundays than on all other days of the week but Wednesdays and Saturdays.

Theft is characterized by a significant day of the week difference in incident frequency ($\chi 2 = 397.6$, $p < 0.001$). Post hoc analysis shows that the *Theft* frequency is significantly lower on Saturdays and Sundays than on all other days of the week.

Theft from Trailer is characterized by a significant day of the week difference in incident frequency ($\chi 2 = 397.6$, $p < 0.001$). Post hoc analysis shows that the *Theft from Trailer* frequency is significantly lower on Saturdays and Sundays than on all other days of the week.

Table 3 Mean values (in thousands of EUR) for all combinations of month and incident category in EMEA

Month	1	2	3	4	5	6	7	8	9	10	11	12	Grand mean
Clandestine	0.5		40.5		53.0		34.7	220.3	2.0		53.0	5.0	63.3
Fraud	62.6	55.5	74.4	82.2	50.3	70.1	58.4	78.9	253.2	115.4	61.1	58.0	78.0
Hijacking	313.5	104.3	266.8	201.5	217.7	407.9	203.8	419.7	114.2	497.9	176.3	288.6	271.4
Robbery	56.5	118.0	242.1	296.8	2987.1	114.7	74.2	671.1	161.4	98.6	158.3	238.7	385.5
Theft	18.7	25.9	63.0	78.3	25.9	26.6	60.8	43.4	23.3	18.6	22.0	19.2	32.8
Theft from Container	37.9	40.5	95.6	76.2	51.7	98.2	85.8	380.1	15.9	83.4	53.9	19.7	77.5
Theft from Facility	77.9	113.5	106.3	173.5	140.7	166.5	347.0	251.0	113.8	118.0	77.6	160.2	149.1
Theft from Trailer	38.1	34.6	60.2	55.5	32.5	117.5	44.7	63.7	46.8	48.2	46.6	41.0	49.1
Theft from Train	1.0		19.7	4.0	50.0	67.5		56.5	77.5	6.0			36.3
Theft from Vehicle	30.5	26.9	32.7	29.5	27.7	31.5	29.4	29.2	31.2	32.5	31.1	32.3	30.4
Theft of Container	30.0	118.3	78.5	30.0	178.4	325.0	558.0	18.0	47.0	75.7	0.5	530.7	193.5
Theft of Trailer	363.7	131.1	213.1	112.0	203.4	143.9	93.2	80.5	98.5	69.5	302.3	133.7	170.8
Theft of Vehicle	46.0	62.6	118.0	59.2	63.9	231.5	73.6	78.0	77.1	92.2	53.7	29.1	74.0
Truck Theft	20.2	21.9	22.6	148.3	21.5	23.1	46.2	33.4	22.3	14.0	39.8	38.7	32.8

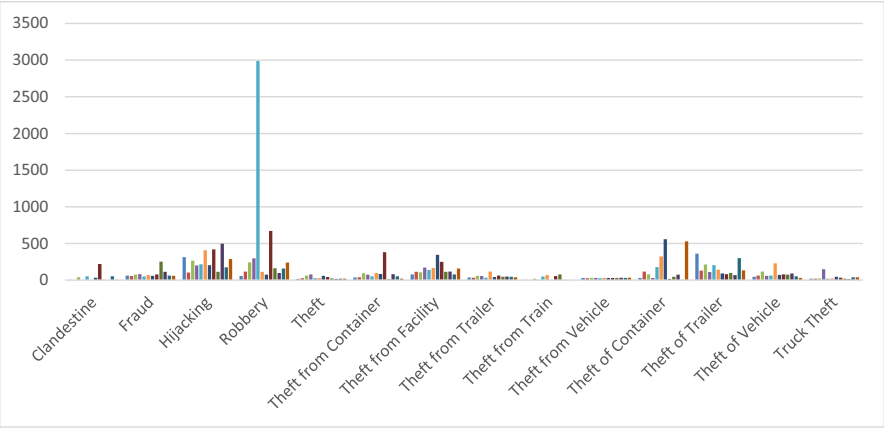

Fig. 3 Mean incident values (in thousands of EUR) for the incident categories in EMEA

Theft from Vehicle is characterized by a significant day of the week difference in incident frequency ($\chi 2 = 2279.4$, $p < 0.001$). Post hoc analysis shows that the *Theft from Vehicle* frequency is significantly lower on Saturdays and Sundays than on all other days of the week. In addition, the *Theft from Vehicle* frequency is significantly lower on Mondays and Fridays than on Tuesdays, Wednesdays, and Thursdays.

Table 6 and Fig. 6 shows the mean total incident value for all combinations of the day of the week and incident category in EMEA. *Clandestine*, *Fraud*, *Hijacking*, *Robbery*, *Theft*, *Theft from Container*, *Theft from Facility*, *Theft from Trailer*, *Theft*

Table 4 Total values (in thousands of EUR) for all combinations of the day of the week and incident category in EMEA

Day of the week	1	2	3	4	5	6	7
Clandestine	606	4	100	61	1	1	240
Fraud	12,779	8521	12,404	11,736	9492	6997	2912
Hijacking	12,454	16,676	23,510	13,692	9371	5996	6769
Robbery	5313	8205	53,414	6192	14,677	3533	1181
Theft	15,495	27,031	10,425	10,787	10,524	3308	4069
Theft from Container	367	3987	265	934	1378	1303	916
Theft from Facility	23,364	21,985	24,363	28,312	43,286	17,618	33,597
Theft from Trailer	3565	4731	8628	6157	6074	1779	2096
Theft from Train	72	124	190	0	90	6	100
Theft from Vehicle	60,760	87,070	94,428	85,748	49,603	20,080	33,765
Theft of Container	1600	352	76	385	811	461	2896
Theft of Trailer	4975	16,626	5468	4499	3606	6286	9623
Theft of Vehicle	25,984	10,847	14,201	9203	16,367	37,235	20,455
Truck Theft	3001	7702	2787	2588	1544	2816	2573

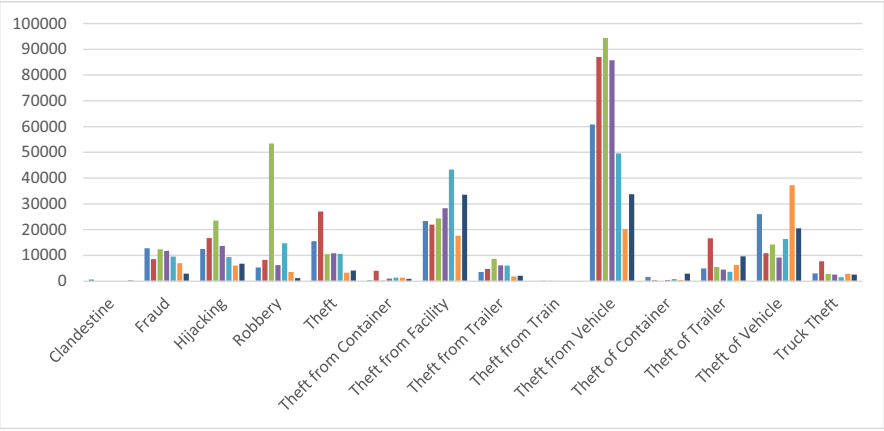

Fig. 4 Total values (in thousands of EUR) for all combinations of the day of the week and incident category in EMEA

from Train, *Theft of Container*, *Theft of Vehicle*, and *Truck Theft* are not characterized by significant differences between months in mean incident value.

Theft from Vehicle is characterized by a significant day of the week difference in mean incident value ($F = 4.8$, $p < 0.001$). Post hoc analysis shows that the *Theft from Vehicle* mean incident value on Sundays is significantly higher than on Mondays, Fridays, and Saturdays.

Theft of Trailer is characterized by a significant day of the week difference in mean incident value ($F = 2.3$, $p = 0.033$). Post hoc analysis shows that the *Theft of Trailer* mean incident value on Tuesdays is significantly higher than on Mondays and Saturdays.

Table 5 Frequencies for all combinations of the day of the week and incident category in EMEA

Day of the week	1	2	3	4	5	6	7
Clandestine	3	2	1	6	1	1	2
Fraud	130	142	131	180	153	67	28
Hijacking	62	59	59	53	49	18	26
Robbery	40	49	34	46	41	13	17
Theft	430	428	447	495	414	177	96
Theft from Container	19	24	16	14	16	15	14
Theft from Facility	232	160	180	163	187	186	183
Theft from Trailer	98	128	122	133	108	37	46
Theft from Train	1	6	4	1	2	1	1
Theft from Vehicle	2202	2793	2909	2696	1870	858	851
Theft of Container	4	4	4	5	7	3	7
Theft of Trailer	46	35	36	36	37	53	56
Theft of Vehicle	285	261	258	256	253	266	236
Truck Theft	120	100	100	107	98	94	83

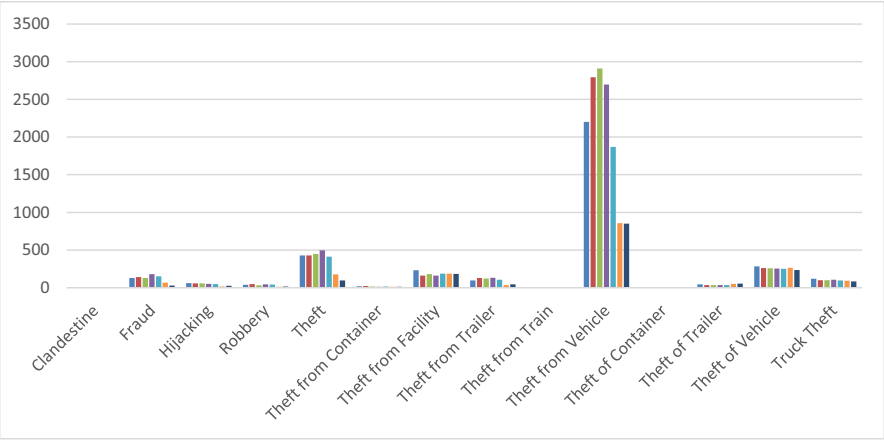

Fig. 5 Frequencies for all combinations of the day of the week and incident category in EMEA

The same types of Tables as 1, 2, 3, 4, 5, and 6, but for APAC and Americas, can be found in the Appendix. In a descriptive perspective, the patterns regarding annual and weekly seasonality are similar, however, because of the much smaller sample sizes for these two areas than for EMEA, the only statistically significant difference is that *Hijacking* in the Americas is characterized by a significant day of the week difference in incident frequency ($\chi 2 = 24.1$, $p = 0.012$). Post hoc analysis, in this case, shows that the *Hijacking* frequency in the Americas is significantly lower on Saturdays than on Mondays, Wednesdays and Fridays.

Table 6 Mean values (in thousands of EUR) for all combinations of the day of the week and incident category in EMEA

Day of the week	1	2	3	4	5	6	7
Clandestine	202.0	2.0	100.0	10.2	1.0	1.0	120.0
Fraud	98.3	60.0	94.7	65.2	62.0	104.4	104.0
Hijacking	200.9	282.6	398.5	258.3	191.2	333.1	260.3
Robbery	132.8	167.4	1571.0	134.6	358.0	271.8	69.5
Theft	36.0	63.2	23.3	21.8	25.4	18.7	42.4
Theft from Container	19.3	166.1	16.6	66.7	86.1	86.9	65.4
Theft from Facility	100.7	137.4	135.4	173.7	231.5	94.7	183.6
Theft from Trailer	36.4	37.0	70.7	46.3	56.2	48.1	45.6
Theft from Train	72.0	20.7	47.5	0.0	45.0	6.0	100.0
Theft from Vehicle	27.6	31.2	32.5	31.8	26.5	23.4	39.7
Theft of Container	400.0	88.0	19.0	77.0	115.9	153.7	413.7
Theft of Trailer	108.2	475.0	151.9	125.0	97.5	118.6	171.8
Theft of Vehicle	91.2	41.6	55.0	35.9	64.7	140.0	86.7
Truck Theft	25.0	77.0	27.9	24.2	15.8	30.0	31.0

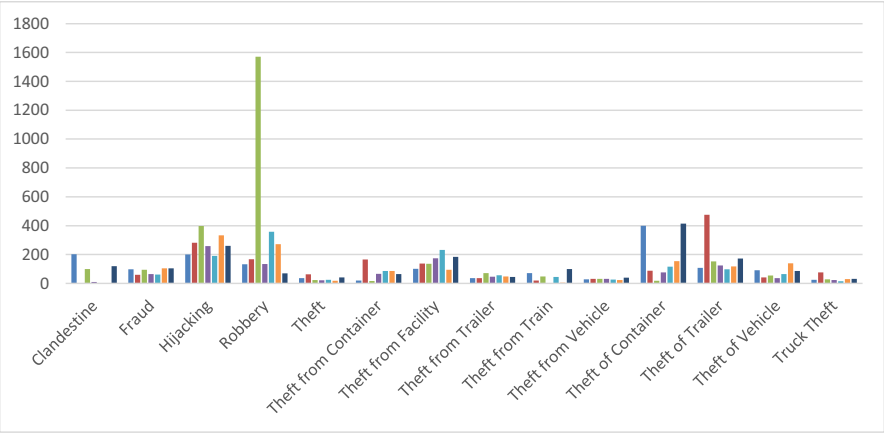

Fig. 6 Mean values (in thousands of EUR) for all combinations of the day of the week and incident category in EMEA

Discussion

The analysis regarding annual seasonality is challenging as the exogenous causes of the seasonality of crime is linked to averaged temperature in any given month, while the regions EMEA, APAC and Americas all include countries in both the northern and the southern hemisphere. Nevertheless, the vast majority of reported incidents, especially in the EMEA, took place in the northern hemisphere. Furthermore, due to that small sample sizes for both the regions APAC and Americas, the statistical effects were too small to yield statistically significant results. The only exception is *Hijacks* in the Americas, which seems to be fewer on Saturdays and a little more common on Mondays, Wednesdays and Fridays (see Appendix Table 17). But it is important to point out the low overall number of incidents in general for both the region Americas and Asia–Pacific. This leads to that the discussion is mainly based on the TAPA EMEA IIS content.

The overall conclusion is that there are seasonal variations of incident categories. This variation is found both between months of the year and between days of the week for many of the incident categories, but the patterns are different for different incident categories. In terms of seasonality on the month of the year based on frequency (see Table 2), there are a few incident categories that show seasonality, in terms of statistical significance. Interestingly, the patterns vary among incident categories.

Many patterns were not statistically significant but interesting from a more descriptive viewpoint. Within this understanding, there are many changes in hot spots, modus operandi, theft endangered objects and handling methods during the time, but the basic theoretical frame of reference is still more or less the same. On overall understanding of the seasonality for time of week indicates that certain potential perpetrators are more prone to change when that attack takes place then how and what they what to steal. The reasoning from the perpetrators' point-of-view is simple. The black-market demand tells them what to steal and the three elements

of crime tells how. Also, in accordance with RAT, any changes in the normal movement/routines of the targets (cargo carriers and facilities) will be reflected into the theft opportunity. Therefore, it is also possible that the seasonal variation in need of transports (Roso and Lumsden 2009) together with the weekly rhythm of the perpetrators affects the theft pattern.

A look at Table 3 (mean value and month of year, EMEA) leads to the conclusion that some incident categories inflict more losses per incident than other categories. *Hijacking*, *Robbery*, *Theft from Facilities, Theft of Container and Theft of Trailer,* all have large losses per incident. Within that understanding, violent MOs like *Hijacking* and Robbery leads to greater value lost per incident. This is in line with other studies (Ekwall and Lantz 2018). In terms of seasonality for the time of year, the data in Table 2 do not support the common idea that violent crimes can be expected to be more common during the warmer season. On the contrary, there is a general summer reduction in the total number of incidents for most categories. Based on this data, we speculate that, as the low point is closely related to the vacation period in Europe that either the thieves and/or the buyers of the stolen products focus on something else during these months.

Seasonal variations in the frequency of incidents during the week (Table 6) show a similar pattern for most incident categories. It seems to be a question of working day duties as most of the different categories have a frequency drop during the weekend. The drops for incident categories *Theft from Vehicle*, *Theft from Trailer*, *Hijacking*, *Robbery* and *Fraud* are all large. Three of these categories, namely *Hijacking*, *Robbery* and *Fraud*, require normal working activities to be able to commit. Both *Hijacking* and *Robbery* need personnel to threaten with violence and there are more people available for these activities during a normal working day than during the weekend. The same reasoning is valid for *Fraud* as they also require the deception (not violence) of normal personnel. Comparisons with the mean value for these categories (*Hijacking*, *Fraud* and *Robbery*) do not give the same picture. This may depend on the lower number of available targets leads to that the perpetrators are better prepared and thereby have the possibility of attacking larger shipments and stealing a higher value during weekends than during a normal working day. Both these conclusions around seasonal variations weekly for *Hijacking*, *Fraud* and *Robbery* fall back on the RAT from criminology.

The analysis of TAPA IIS statistics concerning seasonality in different incident categories indicates that there is such seasonality and that different categories have somewhat different seasonality's both over the year and over the week. This study can't make any deeper conclusion than that the different perpetrators ability to utilize the different crime opportunities together with seasonality demand for stolen products is the key issue. The theft opportunity depends on the perpetrator's ability to use the routines of the target in combination with the lack of security at a certain location (Ekwall 2010). This signals that the different risk factors for cargo theft (Liang et al. 2022), needs to be seen together as different perspectives while analysis certain theft patterns based on cargo type, location, types, geographical region, mode of transport and security level which together makes up the theft opportunity.

One likely conclusion is that the different decision process outcomes from different perpetrators lead to a perpetrator having a favour time/place/method combination

for cargo theft. According to Kroneberg et al. (2010) do actors often *"stick to a particular action alternative in an automatic-spontaneous mode of decision making, which leaves aside other alternatives and incentives*". Thus, criminal behaviour both can be easy to predict (repeating earlier behaviour regardless of incentives or security efforts) and at the same time very dynamic due to the bounded rationality of the perpetrator (Ekwall 2012).

Conclusion

We can conclude that both research hypotheses were supported. Firstly, there are seasonality patterns in incident types for the time of year in cargo theft. The yearly seasonality is mainly demonstrated as a reduction of crimes during the late spring and summer. This may depend on a reduction in the number of available targets from a perpetrator point of view. The primary annual seasonal effect for incident types in cargo theft seems, in general, to be a reduction of attacks during the summer months, while the mean value per incident says about the same throughout the year. Thus, the change in total value is linked more to theft occurrences than to lost values, as about the same mean value, in the same incident category, do not vary significantly.

Secondly, there are seasonality patterns in incident types for the time of the week in cargo theft. The weekly seasonality is demonstrated as a reduction of crimes during the weekend. This may depend on a reduction in the number of available targets from a perpetrator point-of-view or that some of the incident categories are not discovered directly when the crime is committed but is detected at the start of a new work week, normally a Monday or in some cases a Sunday. The lack of reliable time of day in the TAPA IIS database means that there is no solid answer here. The incident types *Hijacking*, *Robbery* and *Fraud* do all require a person to either threaten or foul, which may lead to these types of incidents having working day seasonality. Furthermore, this would also lead to that the data about these incidents are more reliable than for other incidents. For the incident types *Hijacking* and *Robbery,* the idea of the weakest link work here as if the physical security is considered too good, from the perpetrators point-of-view, violence towards the personal becomes an alternative solution to bypass security efforts (Ekwall and Lantz 2018).

The differences in the mean value for an attack for different incident categories may indicate that crime often reflects the risk, effort, and payoff as assessed by the perpetrator (Clarke 1995). A perpetrator acts according to RAT, seeking to maximize his utility concerning a particular time and available resources (Bodman, and Maultby 1997). This may lead to the understanding that different theft opportunities are repeated or re-created on a regular basis. This may very well depend on the endeavour for predictability and routines, from the supply chain operational actors, which then can be utilized as a repeating theft opportunity by a potential perpetrator. This follows the logic of the weakest link (cf. Jażdżewska-Gutta and Borkowski 2022) and the understanding of risk factors (Liang et al. 2022). In terms of practical implications, it is important that stakeholders understand how their decisions and actions affects the different theft

opportunities thru alterations of the risk factors. For instance, decisions leading up to longer waiting time for trucks before delivery, increases the time window for a theft opportunity (cf. TT Club 2022). Thus, perpetrators may specialisation in a certain incident type (combination of the target, modus operandi and time/place) to maximize their effort. Incident types like *Hijacking* and *Robbery are* normally linked to higher attention from authorities (higher conviction risk) as well as a more severe punishment, if convicted. This leads to that the profit for each attack needs to be higher to cover the crime risk/cost viewed from the perpetrator's perspective (Tables 2 and 5). The data in the TAPA IIS database needs to be further analysed to provide a better understanding of the potential effects from perpetrators' specialisation on specific incident types (including MOs), cargo types and geographical locations.

Implications for research

Following the understanding of the impact on business from cargo theft, globally, this paper adds to the body on knowledge about the problem by analysing seasonality in incident types. More research is needed, using different method and data sources (Liang et al. 2022), to better understand the research gaps. Furthermore, the analysis of cargo theft needs to be framed within the needs and demands from the actors in and context of the regular supply chain including the global freight system as well as the international regulatory frame for each actor's liability in a specific incident. Hence, cargo theft can be described as a root cause for Supply Chain Disruption (cf. Ekwall and Lantz 2018).

Implications for practitioners

The practical understanding to RAT is that routines in SCM and transport chains also comes with a downside. The obvious upside is stressed in any regular textbook about logistics and SCM. Simply put, routines provide predictability, but this predictability can be utilized by cargo thieves. As stressed by TT Club (2022), insiders are becoming an increasing source of theft. Because they know the routines and procedures in place, they are well equipped to utilize theft opportunities. However, as this paper explores seasonality patterns on an aggregated level, it may look like the predictability of the movement of goods is better than it actually is.

The six major risk factors in cargo theft (Liang et al. 2022), all together stresses the understanding to what contributes to theft opportunities. The knowledge that perpetrators may specialize in a certain method of theft to maximize their results could aid the development of managerial approaches to security. Furthermore, a better understanding for black market demand for certain products (cf. Ekwall 2009; Ekwall and Kovacs 2021) also would guide the security professionals what to protect better.

Appendix

Table 7 Total values (in thousands of EUR) for all combinations of month and incident category in APAC

Month	1	2	3	4	5	6	7	8	9	10	11	12
Fraud	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Hijacking	1.4	0.0	0.0	0.0	3.9	14.4	0.4	76.1	0.0	44.0	0.0	0.0
Robbery	40.3	0.0	0.0	0.0	0.0	2.0	0.0	11.0	32.6	0.0	0.0	0.0
Theft	11.5	0.0	34.4	0.0	9.7	3.8	2.6	75.1	39.7	0.5	8.2	0.6
Theft from Container	0.0	0.0	0.0	0.7	0.0	0.0	0.0	8237.7	0.0	0.0	0.0	1777.0
Theft from Facility	1.4	534.9	18.6	8.4	93.1	62.1	10.7	1.1	11.4	133.5	91.3	91.2
Theft from Train	0.0	0.0	0.0	0.0	0.0	0.0	10.2	0.0	0.0	0.0	0.0	0.0
Theft from Vehicle	3.3	142.5	0.7	0.1	0.3	20.5	25.1	17.1	6.7	10.3	0.6	29.4
Theft of Container	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	70.0	0.0	15.7	0.0
Theft of Trailer	0.0	31.5	0.0	0.0	30.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Theft of Vehicle	0.0	8.4	3.9	0.0	0.0	7.0	2.7	66.6	0.9	10.3	33.6	12.0

Table 8 Frequencies for all combinations of month and incident category in APAC

Month	1	2	3	4	5	6	7	8	9	10	11	12
Fraud	0	0	0	0	0	0	1	0	0	0	0	0
Hijacking	1	0	0	0	2	2	1	3	0	2	0	0
Robbery	1	0	0	0	0	1	0	2	1	0	1	0
Theft	3	0	3	0	2	1	1	3	3	1	1	1
Theft from Container	0	0	0	1	0	0	0	1	0	0	0	1
Theft from Facility	3	6	3	3	9	8	4	2	5	3	7	7
Theft from Train	0	0	0	0	0	0	1	0	0	0	0	0
Theft from Vehicle	1	5	2	1	1	2	2	2	2	1	2	2
Theft of Container	0	0	0	0	0	0	0	0	1	0	1	0
Theft of Trailer	0	1	0	0	1	0	0	0	0	0	0	0
Theft of Vehicle	3	2	2	0	1	2	1	3	1	3	2	1

Table 9 Mean values (in thousands of EUR) for all combinations of month and incident category in APAC

Month	1	2	3	4	5	6	7	8	9	10	11	12
Fraud							0.1					
Hijacking	1.4				1.9	7.2	0.4	25.4		22.0		
Robbery	40.3					2.0		5.5	32.6			
Theft	3.8		11.5		4.8	3.8	2.6	25.0	13.2	0.5	8.2	0.6
Theft from Container				0.7				8237.7				1777.0
Theft from Facility	0.5	89.1	6.2	2.8	10.3	7.8	2.7	0.5	2.3	44.5	13.0	13.0
Theft from Train							10.2					
Theft from Vehicle	3.3	28.5	0.3	0.1	0.3	10.3	12.6	8.6	3.3	10.3	0.3	14.7
Theft of Container									70.0		15.7	
Theft of Trailer		31.5			30.9							
Theft of Vehicle		4.2	2.0			3.5	2.7	22.2	0.9	3.4	16.8	12.0

Table 10 Total values (in thousands of EUR) for all combinations of the day of the week and incident category in APAC

Day of the Week	1	2	3	4	5	6	7
Fraud	0.0	0.0	0.5	0.0	0.0	0.0	0.0
Hijacking	70.4	0.0	726.9	763.2	15.3	152.5	67.3
Robbery	97.9	0.0	0.0	0.0	0.1	199.9	29.6
Theft	16.1	68.8	208.5	198.8	0.0	114.7	0.0
Theft from Container	0.0	24,713.0	1777.0	2.1	0.0	0.0	0.0
Theft from Facility	340.1	864.2	89.0	521.3	190.2	2933.5	125.3
Theft from Train	0.0	0.0	0.0	0.0	0.0	0.0	10.2
Theft from Vehicle	769.6	100.7	1276.9	143.2	19.2	166.3	42.9
Theft of Container	15.7	0.0	0.0	0.0	70.0	0.0	0.0
Theft of Trailer	0.0	31.5	0.0	0.0	0.0	30.9	0.0
Theft of Vehicle	146.4	14.9	331.9	163.1	44.7	157.7	201.2

Table 11 Frequencies for all combinations of the day of the week and incident category in APAC

Day of the Week	1	2	3	4	5	6	7
Fraud	0	0	1	0	0	0	0
Hijacking	1	0	3	2	2	1	2
Robbery	1	0	0	0	1	3	1
Theft	2	5	4	5	0	3	0
Theft from Container	0	1	1	1	0	0	0
Theft from Facility	4	10	3	13	8	15	7
Theft from Train	0	0	0	0	0	0	1
Theft from Vehicle	6	2	3	3	3	4	2
Theft of Container	1	0	0	0	1	0	0
Theft of Trailer	0	1	0	0	0	1	0
Theft of Vehicle	3	1	3	2	3	6	3

Table 12 Mean values (in thousands of EUR) for all combinations of the day of the week and incident category in APAC

Day of the Week	1	2	3	4	5	6	7
Fraud			0.5				
Hijacking	70.4		242.3	381.6	7.7	152.5	33.7
Robbery	97.9				0.1	66.6	29.6
Theft	8.0	13.8	52.1	39.8		38.2	
Theft from Container		24,713.0	1777.0	2.1			
Theft from Facility	85.0	86.4	29.7	40.1	23.8	195.6	17.9
Theft from Train							10.2
Theft from Vehicle	128.3	50.4	425.6	47.7	6.4	41.6	21.5
Theft of Container	15.7				70.0		
Theft of Trailer		31.5				30.9	
Theft of Vehicle	48.8	14.9	110.6	81.6	14.9	26.3	67.1

Table 13 Total values (in thousands of EUR) for all combinations of month and incident category in Americas

Month	1	2	3	4	5	6	7	8	9	10	11	12
Fraud	689.0	3770.0	13,000.0	259.0	144.3	0.0	0.0	161.4	0.0	0.0	4.7	105.1
Hijacking	96.8	37.6	389.8	149.6	313.8	79.0	731.6	207.3	23.1	108.6	3449.7	28.7
Robbery	83.7	4.6	59.4	4.1	1302.1	5.0	35,969.6	23.9	49.0	21.2	85.7	166.0
Theft	2.2	203.0	0.0	469.2	0.0	0.3	159.0	0.2	46.0	1.1	1.8	46.1
Theft from Container	0.0	0.0	0.0	384.2	0.0	0.0	0.0	0.0	117.8	0.0	0.0	0.0
Theft from Facility	59.2	85.6	0.0	0.1	4.4	2738.1	61.1	504.4	2767.4	152.3	10.4	21.6
Theft from Trailer	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0
Theft from Vehicle	160.6	34.0	91.2	35.1	291.9	288.8	200.8	14.3	253.3	14.3	50.8	0.9
Theft of Container	0.0	0.0	0.0	0.0	13.0	6561.5	0.0	0.0	0.0	0.0	0.0	0.0
Theft of Trailer	7.4	0.0	48.8	248.2	199.8	89.0	0.0	452.6	0.0	43.0	0.0	5.5
Theft of Vehicle	570.5	15.2	15.1	192.8	47.1	71.3	118.1	209.4	72.3	404.8	171,940.0	60.4
Truck Theft	0.0	0.0	8.2	0.0	0.0	0.0	89.6	0.0	0.0	0.0	0.0	0.0

Table 14 Frequencies for all combinations of month and incident category in Americas

Month	1	2	3	4	5	6	7	8	9	10	11	12
Fraud	1	1	1	1	1	0	0	2	0	0	1	1
Hijacking	19	11	16	16	11	7	6	5	4	10	12	9
Robbery	7	1	3	2	4	1	1	1	2	2	6	1
Theft	13	1	0	2	0	3	1	6	6	8	8	2
Theft from Container	0	0	0	1	0	0	0	0	1	0	0	0
Theft from Facility	3	6	0	1	1	5	5	5	3	9	3	6
Theft from Trailer	0	0	0	0	0	1	0	0	0	0	0	0
Theft from Vehicle	2	2	4	1	5	3	4	4	3	3	3	3
Theft of Container	0	0	0	0	1	1	0	0	0	0	0	0
Theft of Trailer	3	0	2	1	1	1	0	2	0	2	0	1
Theft of Vehicle	7	2	3	7	1	5	11	4	2	5	6	6
Truck Theft	0	0	1	0	0	0	1	0	0	0	0	0

Table 15 Mean values (in thousands of EUR) for all combinations of month and incident category in Americas

Month	1	2	3	4	5	6	7	8	9	10	11	12
Fraud	689	3770	13,000	259	144			81			5	105
Hijacking	5	3	24	9	29	11	122	41	6	11	287	3
Robbery	12	5	20	2	326	5	35,970	24	25	11	14	166
Theft	0	203		235		0	159	0	8	0	0	23
Theft from Container				384					118			
Theft from Facility	20	14		0	4	548	12	101	922	17	3	4
Theft from Trailer						2						
Theft from Vehicle	80	17	23	35	58	96	50	4	84	5	17	0
Theft of Container					13	6561						
Theft of Trailer	2		24	248	200	89		226		22		6
Theft of Vehicle	81	8	5	28	47	14	11	52	36	81	28,657	10
Truck Theft			8				90					

Table 16 Total values (in thousands of EUR) for all combinations of the day of the week and incident category in Americas

Day of the Week	1	2	3	4	5	6	7
Fraud	13,105	3770	259	0	965	0	195
Hijacking	1990	2625	9551	1977	46,268	137	596
Robbery	407	385	254	36,029	3505	2038	183
Theft	943	203	287	110	175	1	0
Theft from Container	384	117	0	0	0	0	0
Theft from Facility	13,360	2818	452	8429	882	714	0
Theft from Trailer	1	0	0	0	0	0	0
Theft from Vehicle	71	353	753	1916	1751	0	86
Theft of Container	0	0	0	0	0	6561	12
Theft of Trailer	355	103	0	0	10	80	1103
Theft of Vehicle	810	1305	1,031,877	1198	3397	975	2565
Truck Theft	89	0	0	0	8	0	0

Table 17 Frequencies for all combinations of the day of the week and incident category in Americas

Day of the Week	1	2	3	4	5	6	7
Fraud	2	1	1	0	4	0	1
Hijacking	24	21	26	20	23	4	8
Robbery	6	6	5	7	2	3	2
Theft	3	2	15	18	7	5	0
Theft from Container	1	1	0	0	0	0	0
Theft from Facility	4	10	11	6	3	6	7
Theft from Trailer	1	0	0	0	0	0	0
Theft from Vehicle	6	6	5	7	12	0	1
Theft of Container	0	0	0	0	0	1	1
Theft of Trailer	5	2	0	0	1	2	3
Theft of Vehicle	13	10	8	9	3	6	10
Truck Theft	1	0	0	0	1	0	0

Table 18 Mean values (in thousands of EUR) for all combinations of the day of the week and incident category in Americas

Day of the Week	1	2	3	4	5	6	7
Fraud	6552.5	3770.0	259.0		241.3		195.0
Hijacking	82.9	125.0	367.3	98.9	2011.7	34.3	74.5
Robbery	67.8	64.2	50.8	5147.0	1752.5	679.3	91.5
Theft	314.3	101.5	19.1	6.1	25.0	0.2	
Theft from Container	384.0	117.0					
Theft from Facility	3340.0	281.8	41.1	1404.8	294.0	119.0	0.0
Theft from Trailer	1.0						
Theft from Vehicle	11.8	58.8	150.6	273.7	145.9		86.0
Theft of Container						6561.0	12.0
Theft of Trailer	71.0	51.5			10.0	40.0	367.7
Theft of Vehicle	62.3	130.5	128,984.6	133.1	1132.3	162.5	256.5
Truck Theft	89.0				8.0		

Acknowledgements The authors thank TAPA (www.tapa-global.org) for allowing them to use the data in their IIS database for this research. The authors are named alphabetically and answer equally to all matters within this paper.

Funding Open access funding provided by University of Boras.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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