VALUE AND INCIDENT CATEGORIES FOR CARGO THEFT IN EUROPE – ANALYSING TAPA EMEA STATISTICS

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ABSTRACT

Purpose of this paper

To analysis the relationship between value (reported stolen value) and different incident categories in order to find patterns and trends in cargo theft within Europe.

Design/methodology/approach

The research is explorative as this type of research is missing in logistics but also deductive as it utilizes theories from criminology. The analysis is based on TAPA EMEA's IIS transport related crime database. The result is analyzed and discussed within a frame of reference consisting of theories from logistics and criminology.

Findings

There are seasonal variations of incident categories. This variation is found both between months of the year and the day of the week for many of the incident categories, but the patterns are different for different incident categories. Within this understanding there are many changes in hot spots, modus operandi, theft endangered objects and handling methods during time, but the basic theoretical frame of reference is still more or less the same.

Research limitations/implications

The research is based on theories deduced from criminology and logistics together with secondary data regarding cargo theft. The geographically limitation to the Europe is done of practical reasons whiles the frame of reference can be used globally for analysis antagonistic threats against transports.

Practical implications

This research is limited by the content and classification within the TAPA EMEA IIS database. Nevertheless, this database is the best available database and the reports comes mainly from the industry itself, represented by the different TAPA members how report their losses anonymous, nevertheless the quality of the data limits the possibility to make normative statements about cargo theft prevention.

What is original/value of paper

This paper is the first within supply chain risk management that utilizes actual crime statistics reported by the industry itself, in order to analyze the occurrence of cargo theft by focusing on the value of the stolen vehicle/goods in relation with incident categories.

Keywords: Supply chain risk, Antagonistic threats, Transport, Value of stolen cargo, Cargo theft incident categories.

1. INTRODUCTION

The research with regard to risks in a supply chain is fairly new and it started with risks and purchase (Khan, 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 et al., 1987). Studies of supply chain risks seldom address the 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 other than terrorism.

The reasons behind mentioning terrorism as the only specific crime against in several supply chain risk papers maybe threefold. First, Sheffi (2001) points out the effects of the World Trade Centre terrorist attacks on the global flow of goods. The effect maybe indirect but were devastating nevertheless. This event and non-antagonistic events such as Hurricane Katrina and other natural disasters demonstrated the power to disrupt or cause uncertainty in supply chains (Elliott, 2005; Peck et al., 2002). Secondly, terrorism fund raising through criminal activities (Hardouin and Weichhardt, 2006), means all terrorism is an antagonistic threat. Third, the tools and strategies for handling antagonistic threats are partly governmental (police and justice system) and partly consequence handling (insurance business and conventions). Different international statistics sources about terrorism show that it is difficult to understand the attention the attacks have gained in comparison to other antagonistic threats (Ekwall, 2010). The explanation for this may be the difference in risk apprehension between individuals and risk aversion - that a larger impact is considered more serious than a higher likelihood for the same risk cost (Aggarwal, and Bohinc, 2012; Sjöberg, 2000; Bernstein, 1996; Ekenberg et al., 2001). Regardless of why criminal activity (except terrorism) was not included in general threats against the supply chain, the criminal problems are there and they need to be understood.

1.1. Background

There is a significant problem with the theft of cargo worldwide. The majority of freight transport in the EU 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 EU, namely the free movement of goods (Europol, 2009). It is estimated that theft represents a loss of at least US$10 billion per year in the United States and US$30 billion worldwide (Barth and White, 1998; Anderson, 2007). These figures are calculated extraordinarily conservatively, since most cargo theft goes unreported and these figures reflect only the value of the items and nothing more (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). The theft of cargo value for the European Union is estimated to be €8.2 billion annually, an average value of € 6.72 per trip (EP, 2007). 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). Even the insurance business has problems separating fraud from real theft, but even if they had accurate numbers they would not share it with the public because of concern about trade secrets and competition. Despite these figures, cargo theft generally has a low priority status in most countries and is often perceived largely as the cost of doing business (EU, 2003). No country, no commodity and no shipper are exempt from the acts of cargo theft (EU, 2003). It has been shown that cargo theft is a grave threat to modern trade (EP, 2007). Different preventive measures have been implemented to mitigate the problem of cargo theft, but the problem persists. According to Clarke et al. (2001) is there mainly two reasons for failures in crime prevention, firstly the unexpected use of new technology. Secondly, crime problems come from failure of people and organisations to prevent common crimes, which methods are well known and practical (Clarke et al., 2001). The reason behind this failure to prevent crimes arises from a number of reasons, like ignorance, lack of resources, unwillingness to expand resources and maybe even because that it is more profitable (or cheaper) to allow the crime than to prevent it (Sampson et al., 2010).

This paper addresses a limited array of risks and uncertainties that are defined as antagonistic threats. Antagonistic threats are demarcated by three key words: deliberate (caused), illegal (defined by law), and hostile (negative impact, in this paper, for transport activities within the EU). 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 are motivated perpetrators with hostile intentions toward the object and/or third party that violate an 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. This leads to that 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 EMEA IIS database in order to find patterns and trends in cargo theft within Europe.

1.2. Research purpose

To describe seasonality patterns for different incident categories with respect to reported cargo theft value in Europe, in TAPA EMEA IIS statistics.

2. FRAME OF REFERENCE

2.1. Road transport and cargo theft

The complexity in logistics can be explained by displaying the four flows always involved in logistics activities. The flows of four logistics are material, resources, information and capital. The four flows of logistics 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 potential perpetrator can also utilize the information flow in order to better plan the theft of goods or commit a fraud which targets the flow of capital.

2.2. Elements of crime, the routine activity and crime forecasting

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 object meets)

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 locality or country of international law. The perpetrator's behaviour can be modelled as acting rational 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 meets. 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 comes together at the same time/place. This means that if one of the three elements is missing than is crime impossible. Any combination of location and target are normally referred to as a crime opportunity. According to Clarke and Cornish (2003) are both a motivated perpetrator and a crime opportunity needed in order 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 perspective in criminology (Cohen and Felson, 1979). This theory provides a strong theoretical foundation for understanding crime and opportunities for crime. The routine activities perspective 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). The routine activity theory states that potential perpetrators may seek locations where their victims or targets are numerous, available, convenient, and/or vulnerable. Felson (1987) uses the illustration of "*how lions look for deer near their watering hole*" to explain the practical relevance of the routine activity perspective. According to Smith et al. (2000), social disorganization in combination with the routine activity theory can provide a wider and better explanation of property crime.

The routine activity perspective 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. The routine activity perspective provides a theoretical foundation regarding antagonistic threats against transports in EU. Thus, when the transport network changes, so does the theft opportunity.

The flipside of routine activity perspective is that crime can be predicted, so called crime forecasting (Gorr et al., 2003). Crime forecasting utilizes so-called hot spot methods and that criminality of certain places shall be recognized by police forces (Langworthy et al., 2000). The main limitation of accuracy in crime forecasting the reliability of the data is made up on small scale data series (Gorr et al., 2003). In this paper do this lead to that reliability of the conclusion for different incident categories is different depending on the total number of reports for each incident category. Nevertheless, the database utilized in this paper is the most complete for this type of problem in EU (Europol, 2009).

2.3. Incident categories for cargo theft

The frame of reference uses the routine activity theory from criminology to explain the interaction between supply chain (goods owner), transport network (goods mover) and motivated perpetrators, where the incident category is determent by each unique configuration of transport chain, location, lack of security and black market demand for the transported goods. A classification of these unique configurations is in this paper referred to as different incident categories. The deductive model used in this paper is presented in figure 2.3.

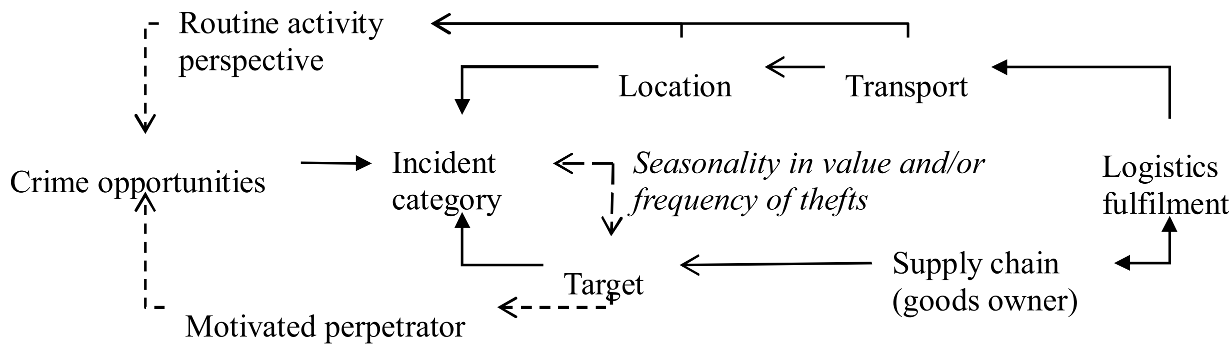

Figure 2.3: Incident category and routine activity perspective for cargo theft

2.4. Seasonality in crimes

In criminological research there is general agreement that crime is to some extent a seasonal phenomenon. According to Cohen (1941) are there two types of seasonality at city level, namely (1) crimes a property (burglary, robbery, and theft) and (2) crimes of aggression (assaults, homicides, and rape). Property crimes are high in fall and winter whiles crimes of aggression peak in midsummer and are lowest in January. Research has formed two general theories on seasonality, namely *temperature aggression hypothesis* and *needs-based view of property crime* (Falk, 1952). The needs-based view of property crime suggests that seasonal unemployment and living expenses influence levels of criminal activity at different times of year (Gorr et al., 2003).

Based on the ‘‘opportunity’’ theories of crime which are routine activities, crime pattern theory, and the rational choice perspective (Felson and Clarke, 1998), the seasonality in crimes can be viewed differently. According to the routine activities (Cohen and Felson, 1979) is crime opportunities concentrated in time and place with regards to the three elements of crime. This leads to that seasonality depends on changes in anyone of these three elements in several different ways. According Hylleberg (1995) are exogenous causes of crime important for understanding seasonality. These causes are *calendar events*, *weather* and *time of year*, which all three causes can increase and decrease criminal behaviour, all depending the local contextual surrounding. The *time of year* can affect crime opportunities in a number of different ways where one example is the Christmas shopping season (Gorr et al., 2003). In short, seasonality in crimes may be found in differences for *time of year* depending on number of available targets and potential customers for stolen goods. It can also be found in *calendar* *events* as day of the week for the similar reasons, but then it has more to do with number of available targets. Furthermore will there be a seasonality difference for different incident categories as crime opportunities differs between the incidents categories.

Hence, the following hypothesis may be formulated:

H1: There are seasonality patterns in incident types for time of year in cargo theft

H2: There are seasonality patterns in incident types for time of week in cargo theft

3. METHOD

All data utilized in this paper is secondary data. According Rabinovich and Cheon (2011) is the use of secondary data analysis 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 nearly 20000 unique reported incidents of crimes against road transport operations within the EMEA area during the years 2000-2011. These reports are done by the different members of TAPA as well as coming from different LEAs (Law Enforce Agency) in EU. For all reports the different company names (both directly and indirectly) involved are removed from the data. This is done in order to achieve better credibility in all reports as no company will receive bad publicity from reporting incidents to the IIS, furthermore it is the reporting entity that decides what and how much to report. This leads to that the quality of the data varied between different incidents. Nevertheless, over the years, has this strategy leaded to that the statistics in TAPA IIS is considered, by far, to be the most accurate in EU for this type of incidents (Europol, 2009). Alternative secondary data available has less attributes and are more likely to have a larger ratio of hidden statistics, different definitions and thereby more difficult to compare between countries (Ekwall, 2010). This leads to the methodological distinction that this statistics (TAPA EMEA IIS) can be considered to really represent the true occurrence of cargo theft incidents, maybe not in absolute numbers, but well as a fully trustworthy picture over time.

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 macro-oriented where the analysis is focusing on EU-wide 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 serves as a reminder for the researches for greater understanding about the aetiology of crime (causes), in other word, that crime are contextual depended (Barclay, and Donnermeyer, 2009).

The different categories are analysed with respect to seasonality within weeks and seasonality within years. We describe and analyse incident values and frequencies with appropriate statistics. Comparison of mean values is 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 between several groups are conducted with chi square tests. If the chi square test is rejected, post hoc analysis is conducted with pairwise chi square tests with Bonferroni correction.

Obviously, when the data in a study is closer to a census than to a random sample, results from regular significance tests become less valuable. The reason, of course, is that in a true census, observed measures of differences and relations coincide with the actual population parameters. Indeed, the data in this study represent a census regarding reported incidents during 2000-2011, and in this regard, our descriptive measures can be seen as actual population parameters. However, we use these data to discuss the future in transportation security, and in this perspective, the data should be seen as a consecutive sample, which creates a need for significance testing.

3.1. Typology road related cargo theft

This paper uses the same definition for different road related cargo theft that is used by both TAPA IIS and Europol (2009). This includes any theft of shipment committed during its road transportation or within a warehouse, but excluding internal petty theft. The following are the definitions used for incident categories in this paper (Europol, 2009):

Hijack - occasions where force, violence or threats are used against a driver and the vehicle/goods is stolen. Hijack includes a forces stop of vehicle

Robbery - occasions where force, violence or threats are used against humans and the vehicle/goods is stolen. Robbery does not include a forces stop of vehicle.

Theft of - where an unattended vehicle and/or trailer are stolen with the load

Theft from - thefts of load from stationary vehicles (e.g. by curtain slashing) or from delivery vehicles left unlocked/unattended

Deception/Diversion - relates to deceptions where drivers/companies are deceived into delivering to a different destination than the intended one (commonly referred to as 'Round the Corner'); including 'e-crime' where bogus logistics companies are established to divert the delivery

Fraud - occasions where intentional deception are used against humans and the vehicle/goods is stolen

Burglary - burglaries of commercial premises which form part of the supply chain in all the above definitions.

4. RESULTS

Table 4.1 describes the observed total incident value for all combinations of month and incident category. As one might have expected, there are large differences between months for many of the incident categories. Hence, a deeper analysis is needed.

Table 4.1: Total values (in thousands of EUR) for all combinations of month and incident category

	Burglary	Fraud	Hijacking	Robbery	Theft	Theft from Facility	Theft from Vehicle	Theft of Vehicle	Truck Theft
January	7315	2156	8364	13104	5418	6290	18011	25926	7320
February	5882	5160	9061	24832	5022	5226	20080	12320	4524
March	3068	1386	24360	10400	12127	9828	16870	12240	4060
April	6851	3264	3723	11856	5310	3245	10050	13020	4225
May	7112	2255	4995	7722	12495	3834	18860	12685	5192
June	1020	3280	7560	9802	5311	3840	9796	14350	4008
July	992	1677	3510	5328	4512	2862	11866	12210	4914
August	3072	3612	7504	33297	4620	2805	9180	11966	2618
September	2289	2192	4784	25844	7467	4526	14476	11466	5720
October	4810	8078	4862	9799	4356	9782	13072	12900	2392
November	3042	10416	5720	21926	6669	6222	13788	19158	3255
December	5706	432	15713	11913	5550	4437	10064	13952	3696
Total	51062	43942	100064	185697	79092	63040	165410	172306	52050

In table 4.2, the mean values for all combinations of month and incident category are displayed. The only incident category for which a significant difference between months can be found is *Theft of Vehicle* ($F=3.907$, $p<0.001$). Post hoc analysis shows that the mean values for June, July and August are all significantly lower than the mean values for November, December and January. Hence, for incidents in the *Theft of Vehicle* category, mean incident values are significantly higher during the winter than during the summer, but other incident categories have no significant seasonality over the year regarding the value of incidents.

Table 4.2: Mean values (in thousands of EUR) for all combinations of month and incident category

	Burglary	Fraud	Hijacking	Robbery	Theft	Theft from Facility	Theft from Vehicle	Theft of Vehicle	Truck Theft
January	209	98	492	273	42	74	31	174	24
February	346	430	533	776	27	67	40	88	26
March	236	66	870	260	67	117	35	90	28
April	403	192	219	304	45	55	25	105	25
May	254	205	333	297	105	54	41	59	22
June	60	205	378	338	47	64	31	70	24
July	62	129	351	148	48	54	34	74	27
August	192	301	469	1009	55	55	30	62	22
September	109	137	299	923	57	73	44	91	26

October	185	577	442	239	36	134	38	150	26
November	169	651	220	577	39	102	36	186	31
December	317	144	827	361	75	87	37	218	22
Average	211	254	472	439	52	80	35	101	25
Levene's test W (p-value)	1,796 (0.056)	4.150 (<0.001)	2.592 (0.004)	3.475 (<0.001)	3.671 (<0.001)	3.880 (<0.001)	1.734 (0.060)	8.130 (<0.001)	3.257 (<0.001)
ANOVA or Brown-Forsythe F (p-value)	0.698 (0.740)	1.679 (0.108)	1.263 (0.257)	1.118 (0.356)	1.266 (0.241)	1.085 (0.373)	0.775 (0.665)	3.907 (<0.001)	1.017 (0.429)

In table 4.3, the frequencies for all combinations of month and incident category are displayed. *Fraud*, *Hijacking* and *Robbery* are not characterised by significant differences between months in incident frequency. *Burglary* is characterised by a significant monthly difference in incident frequency ($\chi2$=21.90, p=0.025), but post hoc analysis does not reveal any significant pairwise differences between months. Theft is characterised by a significant monthly difference in incident frequency ($\chi2$=114.21, p<0.001). Post hoc analysis shows that the *Theft* frequencies are significantly higher in February and March than in any other month except September and November, higher in November than in June, July, August and December, and lower in December than in January and September. *Theft from Facility* is characterised by a significant monthly difference in incident frequency ($\chi2$=25.08, p=0.009), but post hoc analysis does not reveal any significant pairwise differences between months. *Theft from Vehicle* is characterised by a significant monthly difference in incident frequency ($\chi2$=244.72, p<0.001). Post hoc analysis shows that the *Theft from Vehicle* frequency is significantly higher in January than in any other month except February and March, higher in February than in any month between June and December, higher in March and May than in any month between June and December except November, higher in April than in August and December, and higher in November than in December. *Theft of Vehicle* is characterised by a significant monthly difference in incident frequency ($\chi2$=167.67, p<0.001). Post hoc analysis shows that the *Theft of Vehicle* frequency is significantly higher in May than in any other month except June, July and August, higher in June than in any other month except January, May, July and August, higher in July than in October, November and December, higher in August than in April, September, October, November and December, lower in October than January and February, and lower in December than in any other month except October and November. *Truck Theft*, finally, is characterised by a significant monthly difference in incident frequency ($\chi2$=222.73, p<0.001). Post hoc analysis shows that the *Truck Theft* frequency is significantly higher in January than in any other month except May, higher in May than in any other month except January, February, April, July and September, lower in October than in any other month except August and November, lower in November than in any other month except March, August and November, lower in August than in July and September, and lower in March than in September.

Table 4.3: Frequencies for all combinations of month and incident category

	Burglar y	Fraud	Hijackin g	Robber y	Theft	Theft from Facility	Theft from Vehicle	Theft of Vehicle	Truck Theft
January	35	22	17	48	129	85	581	149	305
February	17	12	17	32	186	78	502	140	174
March	13	21	28	40	181	84	482	136	145
April	17	17	17	39	118	59	402	124	169
May	28	11	15	26	119	71	460	215	236
June	17	16	20	29	113	60	316	205	167
July	16	13	10	36	94	53	349	165	182
August	16	12	16	33	84	51	306	193	119
September	21	16	16	28	131	62	329	126	220
October	26	14	11	41	121	73	344	86	92
November	18	16	26	38	171	61	383	103	105
December	18	3	19	33	74	51	272	64	168
Total	242	173	212	423	1521	788	4726	1706	2082
Chisquare (p-value)	21.90 (0.025)	18.79 (0.065)	17.02 (0.107)	12.43 (0.332)	114.21 (<0.001)	25.08 (0.009)	244.72 (<0.001)	167.67 (<0.001)	222.73 (<0.001)

Table 4.4 describes the observed total incident value for all combinations of weekday and incident category. As one might have expected, there are large differences between weekdays for many of the incident categories. Hence, a deeper analysis is needed.

Table 4.4: Total values (in thousands of EUR) for all combinations of weekday and incident category

	Burglary	Fraud	Hijacking	Robbery	Theft	Theft from Facility	Theft from Vehicle	Theft of Vehicle	Truck Theft
Monday	15810	8884	21573	54957	16427	6893	29939	29417	8661
Tuesday	2123	6207	11475	18113	8833	4313	31134	20208	7173
Wednesday	7282	10666	22841	34787	7881	7542	32466	21759	7082
Thursday	4235	5973	18003	31594	15277	7901	26061	20199	7317
Friday	3889	8555	13231	25273	14048	13563	21625	21816	8967
Saturday	6719	1571	1178	8463	6404	8896	10354	26350	6967
Sunday	11063	2050	11823	12698	9996	13675	15010	32211	5978
Total	51121	43905	100125	185887	78866	62783	166589	171959	52145

In table 4.5, the mean values for all combinations of weekday and incident category are displayed. No significant difference between weekdays can be found for any incident category.

Table 4.5: Mean values (in thousands of EUR) for all combinations of weekday and incident category

	Burglary	Fraud	Hijacking	Robbery	Theft	Theft from Facility	Theft from Vehicle	Theft of Vehicle	Truck Theft
Monday	344	306	770	833	61	59	42	112	25
Tuesday	96	194	273	224	34	44	34	82	27
Wednesday	251	368	476	504	33	64	37	98	25
Thursday	184	149	474	372	56	70	30	91	24
Friday	111	342	348	361	55	104	31	85	25
Saturday	153	143	118	339	52	78	31	110	26
Sunday	257	293	1478	470	96	138	43	124	25
Average	211	254	472	439	52	80	35	101	25
Levene's test W (p-value)	2.605 (0.018)	2.020 (0.066)	8.353 (<0.001)	3.739 (0.001)	3.610 (0.001)	5.813 (<0.001)	1.659 (0.127)	1.627 (0.136)	0.708 (0.643)
ANOVA or Brown-Forsythe F (p-value)	1.212 (0.303)	0.632 (0.704)	1.042 (0.449)	1.241 (0.289)	1.032 (0.405)	2.099 (0.052)	1.099 (0.360)	0.849 (0.532)	0.270 (0.951)

In table 4.6, the frequencies for all combinations of weekday and incident category are displayed. *Theft from Facility* and *Theft of Facility* are not characterised by significant differences between weekdays in incident frequency. *Burglary* is characterised by a significant difference between weekdays in incident frequency ($\chi2$=17.75, p=0.007), but post hoc analysis does not reveal any significant pairwise differences between months. *Fraud* is characterised by a significant difference between weekdays in incident frequency ($\chi2$=33.40, p<0.001). Post hoc analysis shows that the *Fraud* frequency is significantly lower on Sundays than on any other weekday except Saturday, and lower on Saturdays than on Tuesdays and Thursdays. *Hijacking* is characterised by a significant difference between weekdays in incident frequency ($\chi2$=48.98, p<0.001). Post hoc analysis shows that the *Hijacking* frequency is significantly lower on Sundays than on any other weekday except Saturday, and lower on Saturdays than on any other weekday except Monday and Sunday. *Robbery* is characterised by a significant difference between weekdays in incident frequency ($\chi2$=59.50, p<0.001). Post hoc analysis shows that the *Robbery* frequency is significantly lower on Saturdays and Sundays than on any other weekday. *Theft* is characterised by a significant difference between weekdays in incident frequency ($\chi2$=143.84, p<0.001). Post hoc analysis shows that the *Theft* frequency is significantly lower on Saturdays and Sundays than on any other weekday. *Theft* *from Vehicle* is characterised by a significant difference between weekdays in incident frequency ($\chi 2=533.30$, $p<0.001$). Post hoc analysis shows that the *Theft from Vehicle* frequency is significantly lower on Saturdays and Sundays than on any other weekday, lower on Fridays than on Mondays, Tuesdays, Wednesdays and Thursdays, and lower on Mondays than on Tuesdays, Wednesdays and Thursdays. *Truck Theft* is characterised by a significant difference between weekdays in incident frequency ($\chi 2=38.05$, $p<0.001$). Post hoc analysis shows that the *Truck Theft* frequency is significantly higher on Mondays and Fridays than on Tuesdays, Saturdays and Sundays.

Table 4.6: Frequencies for all combinations of weekday and incident category

	Burglary	Fraud	Hijacking	Robbery	Theft	Theft from Facility	Theft from Vehicle	Theft of Vehicle	Truck Theft
Monday	46	29	28	66	269	117	711	262	353
Tuesday	22	32	42	81	258	98	910	247	268
Wednesday	29	29	48	69	240	117	882	221	289
Thursday	23	40	38	85	272	113	855	222	303
Friday	35	25	38	70	256	130	693	256	356
Saturday	44	11	10	25	122	114	329	239	272
Sunday	43	7	8	27	104	99	346	259	241
Total	242	173	212	423	1521	788	4726	1706	2082
Chisquare (p-value)	17.75 (0.007)	33.40 (<0.001)	48.98 (<0.001)	59.50 (<0.001)	143.84 (<0.001)	6.59 (0.361)	533.30 (<0.001)	7.14 (0.308)	38.05 (<0.001)

Unfortunately, our data do not support unbiased analyses of the exact timing of the incidents. Indeed, time of incident is one of the variables in the data, but the vast majority of incidents are characterised by either a wide interval (e.g., "between 10 p.m. – 8 a.m.", or "during the night") or an entirely missing value for this variable. We have experimented with different solutions in order to be able to utilise this information in our analyses. For example, we have arbitrarily set the time to the midpoint of the interval (where applicable), and we have tried to construct new time variables by dividing the day into two or three broad categories. However, it is not possible to avoid imprecision and uncertainty. Hence, we do not include the timing variable in the analyses at all.

5. DISCUSSION

There are seasonal variations of incident categories. This variation is found both between months of the year and the day of the week for many of the incident categories, but the patterns are different for different incident categories. The only statistically significant difference in the mean value for incidents categories are between the months of the year for *Theft of vehicle*, and no significant differences between days over the week. All other findings are not statistically significant but nevertheless interesting from a more descriptive view-point. Within this understanding there are many changes in hot spots, modus operandi, theft endangered objects and handling methods during time, but the basic theoretical frame of reference is still more or less the same.

A quick look at table 4.1 leads to the conclusion that *Hijacking*, *Robbery*, *Theft from vehicle* and *Theft of vehicle* are the incident categories with the combined highest lost value, but table 4.2 tells that *Hijacking* and *Robbery* have a much higher value lost per incident. Furthermore has *Robbery* a pike in the end of the summer (August and September) whiles *Hijacking* has a pike in the early spring (March) and one before Christmas (November). Table 4.3 clearly points out the *Hijacking* is not a volume threat whiles *Theft, Theft from vehicle*, *Theft of vehicle* and *Truck theft* are. The different seasonal variations within each incident category depending on mean value and frequency (table 4.2 and 4.3) for *Hijacking* leads to a interesting observation as it is a winter crime (November to April) by frequency whiles by mean value both months standout (November and March). A similar seasonal variation is found for *Robbery* but as a high mean value in the end of the summer (August and September) but in frequency is the pike lesser and the pattern is more similar to *Hijacking.*

Seasonal variations in frequency of incident categories during a week (table 4.6) show a similar pattern as on a yearly basis. The majority of the incidents categories seem to be working day duties as *Burglary*, *Theft from Facility*, *Theft of Vehicle*, *Truck theft* are the only incident categories the show a descriptive even distribution between all seven days of the week. This may depend on the simple fact that the other types of incidents categories (*Hijacking, Fraud* and *Robbery)* require normal working activities in order 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 week end. 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 that the lower number of available targets leads to that the perpetrators are better prepared and thereby have the possibility of attack larger shipments and steal a higher value during weekends than during a normal working day. Both these conclusions around seasonal variations on a weekly basis for *Hijacking*, *Fraud* and *Robbery* fall back on the routine activity perspective from criminology.

The analysis of TAPA EMEA IIS statistics with regard to seasonality in different incident categories points out that there is seasonality and that different categories have different seasonality both over the year and 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). One likely conclusion is that the different decision process outcomes from different perpetrators leads to that a perpetrator has a favour time/place/method combination for cargo theft. According 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*". This leads to that 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 at the perpetrator (Ekwall, 2012).

6. CONCLUSION

We can conclude that both research hypotheses were supported. Firstly, there are seasonality patterns in incident types for time of year in cargo theft.The previously known seasonality in property crimes (increase in fall and winter) (Cohen, 1941) is visible but not in the only category where the seasonality is statistically significant, namely *Theft of vehicle,* where the seasonality is inverted (reduction during the fall). The same is valid for the similar category *Truck theft*. The yearly seasonality is also demonstrated as a reduction of crimes during the late spring and summer. This may depend on a reduction in number of available targets from a perpetrator point-of-view. The seasonality for incident types in cargo theft seems, in general, to be a small reduction of attacks (table 4.3) during the summer months, whiles the mean value for each incident (table 4.2) seems to be spread throughout the year.

Secondly,there are seasonality patterns in incident types for time of week in cargo theft. The weekly seasonality is demonstrated as a reduction of crimes during the weekend. This may depend on a reduction in number of available targets from a perpetrator point-of-view or that the incident categories *Theft, Theft from vehicle*, *Theft of vehicle* and *Truck theft* are incident types which are discovered and the beginning of next week instead for during the weekend. The lack of reliable time of day in TAPA EMEA IIS database gives no good answer here. The incident types *Hijacking*, *Robbery* and *fraud* do all require a person to either threat or foul, which may lead to that these types of incidents have working day seasonality.

The differences in 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 rational choice theory, seeking to maximize his utility with regard to a particular time and available resources (Bodman, and Maultby, 1997). This leads to that perpetrators may specialize in a certain incident type (combination of target, modus operandi and time/place) in order to maximize their own effort. Incident types like *Hijacking* and *Robbery* normally are linked to a 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 in order to cover the crime risk/cost viewed from the perpetrators perspective (table 4.2 and 4.5). The data in TAPA EMEA IIS database needs to be further analysed in order to provide a better understanding of this type of antagonistic threats. The results in this paper support previous research (Ekwall, 2009; Ekwall, 2010) that the perpetrator need to be included into the analysis of cargo theft.

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