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Railway station boarding controls: issues and limits. Performing security to secure performance?

Les contrôles à l'embarquement en gare : enjeux et limites

Controles de embarque en estaciones de ferrocarril: desafíos y límites

Nacima Baron and Nils Le Bot

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Abstracts

English Français Español
Should terminal station operators take steps against terrorist events by developing security checks or should they rely on open transit systems and smooth pedestrian flows as key factors of security prevention? The authors argue that the necessity to articulate fluidity and security strategies in saturated transport places necessitates a careful approach of the spatial insertion of passenger flow as well as a contextual - and critical - perspective of security governance in stations. The demonstration is developed in two stages. Based on a worldwide census and a critical analysis of these events, this article makes a clear correlation between the increase of terrorist attacks in railway stations and the installation of boarding controls. The study of the different positions of these security devices gives a typology of possible access control perimeters. The case of Paris Nord Station boarding controls is then studied in more detail. There, the security gates destabilise boarding and circulation to the point that they are regularly neutralised in order to limit the crowding problems they create. Yet, the devices remain in place since 2015 Thalys attacks for their performing value and because of the State will make visible and enact a permanent defence to terrorist risk, through space.

Les gestionnaires de gares doivent-ils agir face à la menace terroriste en implantant des portails de sécurité, ou bien doivent-ils favoriser l'ouverture et la libre circulation piétonne comme facteurs de prévention et de résilience face à ce risque ? Cette question est abordée en deux temps. Partant d'un recensement mondial et d'une analyse critique de ces événements, cet article établi une corrélation évidente entre l'augmentation des attaques terroristes dans les gares et l'installation croissance de portiques. L'étude des multiples positionnements de ces dispositifs sécuritaires permet de constituer une typologie des périmètres de contrôle d'accès possibles. Le cas des installations de contrôle en Gare de Paris Nord est ensuite étudié plus en détail. Dans ce cas, les portails de sécurité déstabilisent le processus d'embarquement et la circulation au point qu'ils sont régulièrement neutralisés pour limiter la congestion induite. Pourtant, ces appareils restent en place depuis les attaques de 2015 pour leur fonction performative et du fait de la volonté de l'État de rendre visible et d'incarner, par l'espace, l'existence d'une réponse permanente au risque terroriste.

¿Deberían los operadores de las estaciones ferroviarias tomar medidas frente a los actos terroristas mediante el desarrollo de controles de seguridad? O más bien ¿deberían confiar en los sistemas de tránsito abiertos de flujos peatonales como factores claves en la prevención de seguridad?
Los autores argumentan que es necesario articular estrategias de fluidez y seguridad en espacios de transporte que ostentan una saturación. Estos espacios requieren un enfoque considerando la componente espacial en los flujos de pasajeros y una perspectiva crítica a la gobernanza de la seguridad en tales estaciones. La demostración de lo anterior se desarrolla en dos etapas. La primera, sostenida por el apoyo de un censo mundial y la segunda, por un análisis crítico de estos eventos. Los resultados expresan una alta correlación entre el aumento de ataques terroristas y la creciente instalación de pórticos de control en estaciones de ferrocarril. Además, estudiamos las disposiciones de estos dispositivos de seguridad permitiendo observar una tipología de posibles perímetros de control de acceso. A partir del estudio de caso de la Estación de París Norte en sus controles de embarque analizados en detalle, observamos que las puertas de seguridad desestabilizan el proceso de embarque y circulación hasta tal punto que se neutralizan estos controles periódicamente para limitar los problemas de hacinamiento que se generan. Sin embargo, los dispositivos restan en su lugar desde los ataques ocurridos el año 2015 al tren Thalys, dada su función y por la voluntad del Estado de visibilizar y plasmar en el espacio la existencia de una respuesta permanente al riesgo terrorista.

Index terms

Mots-clés : sécurité, gare, piéton, flux, modélisation, protection, transport
Keywords : security, railway station, pedestrian, flow, modelling, transport
Palabras claves : seguridad, estación de ferrocarril, peatón, flujos, modelización, transporte

Full text

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Introduction

1 The terrorist attacks in Madrid Atocha in 2004 and Mumbai in 2008 raised public awareness about the vulnerability of transportation infrastructures, in particular transit and terminal stations (Johnstone 2015). Transportation companies faced political pressure to organize security checks and a discussion was open and never closed among security experts (or so-called experts) and railway operators (Fiumara 2015, UIC 2017). Raffaello Pantucci considers that: "*Airplanes leave from a specific place - you can build a security apparatus around them, while it's just not possible to do that with trains.*

You would have to do that at every station from large terminals in Paris to small towns in rural France" (EU Report 2018, p 33). Conversely, Hervé Borrion, former SNCF Director and now in charge of security and safety questions at Union Internationale des Chemins de fer, advocates for a careful but effective implementation of security checkpoints: "*Planners can come to the aid of railway operators by designing security checkpoints that harmonize conflicting goals of a railway operation*" (Borrion et al. 2014 191).

2 The aim of this paper is to address the question from the perspective of station building geospatial feature, because a strategic vision of space and place plays a crucial role in such choices. In theoretical terms and from a macro perspective, what is the real or imagined impact of the terrorism in terminal stations, and is that threat now driving changes in station spatial layout? The response is yes, and we want to explore, in the line of other geographers that have questioned cities in times of terror (Savitch 2008), how railway managers address real and purported terrorist threats and reorganize contemporary urban nodes. In section 1, a survey shows the increase in attacks and their geographical distribution around the world. It identifies the countries that have adopted gating options, their reasons for so doing, and advances a spatial typology defining the different possibilities for gate location.

3 Another question is to be able to describe geographically the inherent problems in securitizing railway stations and achieving balance between public safety, collective rights to privacy and to a transport quality service. In empirical terms and from a micro perspective, what is the impact of a security apparatus positioned at the entry to a platform? Section 2 reports on an extensive observation of boarding for the Thalys international train service at Paris Gare du Nord, even if it may be noted that the context here is very specific. Measurements of the disruption caused reveal the limitations of this option: security risks may be accentuated when gates lead to longer boarding lines and excessive pressures on passenger flows.

4 The paper's scientific contribution is to provide a better and more critical understanding of the operational difficulties faced by railway authorities and governments when airport-like solutions are hastily applied to stations. It concludes with a discussion on the limits of reproducibility of this case, for operational and political reasons, and on how security thresholds can be integrated technically and strategically into terminal stations.

1. The vulnerability of terminal stations to terrorist attacks

1.1. Stations are critical infrastructures

5 In the European Union as well as on other continents, terminal stations are seen as soft urban targets (Gatinessi 2018). If terrorism correspond to premeditated, politically motivated violence, perpetuated against non-combatant targets by sub-national groups or clandestine agents, and if its very definition has to be carefully delineated from other forms of urban violence such as guerilla or insurgent movements, mobility hubs in general and railway premises in particular are considered as critical infrastructures. Strandh considers that they are vulnerable to terrorism for at least three reasons (Strandh 2017). First, they concentrate significant numbers of civilians in crowded and confined spaces, so any terrorist attack could result in multiple casualties as well as

major infrastructure damage (also Jenkins 2012, Strandberg 2013). Second, transit terminals are interconnected systems: any attack has the potential to cause cascade effects and significant transport system breakdown (Strandh 2015). Third, stations are already associated with stress, insecurity, and fear of crime (Cozens 2003), so they are a preferential target for terrorists who seek publicity in order to maximize their impact on public opinion and mood (Shvevtsov 2017).

6 Knowing more exactly the number, location, circumstances of terrorist attacks to stations is not an easy task. There have been many assessments of the number of people affected by terrorist attacks in transport systems. Databases offer quite different facts and figures (for example MTI, GTD and RAND databases, see table below), other are less accessible (be they on subscription or managed by independent official or private bodies in counterterrorism services) and some are produced by researchers with different methodologies and often complementary sources (newspaper, official records, ...). Two main open information sources are RAND database of worldwide terrorism incidents (Wilson 2007, Jenkins and Butterworth 2010) and the Global Terrorism Database, GTD. Transportation appears in both bases as a single category including attacks directed at subway and metro lines and stops, BRT, light rail, bus stations and bus stops, as well as terminal stations. For us, GTD is the most exhaustive but requires a careful filtering of each case in order to check that the railway station is targeted by terrorists. Experts own databases, quite different in time period covering, in target (rail bound traffic or specifically metro stations) give different statistical results but confirm the main tendencies. De Cellist et al. 2013 present their own database and record 541 terrorist assaults worldwide at stations between 1972 and 2011, but they also include criminal "*incidents*" (De Cillis et al. 2013). Holgersson & Björnsting, having enriched GDT database, conclude that the number of terrorist events has increased significantly in the 21st century (Holgersson & Bjornsting 2014) and give the approximation of 170 attacks to station. Shvetsov et al 2016 considers 39 attacks in 14 countries between 1985 and 2017 in metro and underground stations. Strandh analyzes attacks against rail-bound traffic in general from 1970 to 2013 and concludes that 22% of the 1,122 attacks identified since then have been specifically aimed at stations (this makes a total of approximately 200 attacks worldwide) (Strandh 2017). Other data are provided by experts focusing exclusively on car bomb attacks against transport infrastructure (Shvetsov et al. 2019) unfortunately don't separate terminal stations from other targets.

7 We are very conscious that databases can be affected by errors, incompleteness and, in some case, overestimation. In order to clarify the figures, we established a shortlist from the biggest compilation (GTD) and filtered the 6,900 attacks perpetrated against all transportation modes and all types of terminal station between 2001 (a date that represented obviously a turning point in urban and transportation security (Franzen 2001) and 2017. This gave us the 254 terrorist attacks to station since 2001 that are the corpus on which we have worked.

Table 1: Assessing railway station vulnerability to terrorism: Sources and databases

Databases	Period covered	Nature and availability	Scope	Identification of railway station terrorist attacks
RAND Database of Worldwide terrorism (RDWTI)	1970-2009	Public	main terrorist attacks occurred worldwide	87 records from 1981 to 2008 and include railway stations, railway tracks, and intents of terrorist attacks as

				well as
Global terrorism Database GTD	1970 - now	Public	all terrorism events in the world	more than 634 events from 1972 to 2018 including railway station and other railway premises
MTI Minnesota	1920 - now	By subscription	all events occurred worldwide against public surface transportation	more than 800 events including railway station and other railway premises. No easy capacity to delineate railway station attacks
Shvevtsov 2017	1887 - now	Own expert's database (not diffused)	metro and underground stations only	81 events analyzed concerning underground metro stations, no surface stations
De Cillis 2013	1970-2011 and updated	RISTAD (Railway Infrastructure Systems Terrorist Attacks + Database produced in METRIP (EU research program)	railbound traffic i.e. railway station and its environment (tracks, trains...)	541 events analyzed on rail bound traffic and 110 attacks identified to railway stations during the period
Annelie Holgersson & Ulf Björnstig 2013		GTD Database + open sources, scientific journals	public transport: trains, buses, trams, subways, ferries, airplanes, airports, stations	447 events recorded from 1970 to 2009 and 38 % that is to say about 170 attacks to stations

Source: quoted from De Cillis and al. 2013 and updated and enriched by authors

8 Figure 1 shows the numerical breakdown between attacks occurring at bus stations and bus stops (344), sabotage to railway tracks (350), and attacks perpetrated in or at stations (254). It also confirms that the incidence of such events at stations is steadily growing, though with significant year-to-year variability. Out of a total of 254 events at terminal stations, 91 attacks were perpetrated from 2001 to 2009 and 165 from 2010 to 2018 (an increase of 81%). In the last decade, 68 attacks were recorded from 2010 to 2013 and 87 from 2014 to 2017 (+ 28% between these two periods). The information on geographical targets is consistent with existing literature (Asal et al 2012). As GTD is the biggest database available, the broad approach of terrorism includes attacks to station perpetrated during wars (Russia and Ukrania) as well as at the occasion of nationalist and ethnic separatist groups operating in guerrilla contexts (Maoist guerilla groups (Jarkhand, Bihar and Odisha States in India, Pakistan) and attacks in European capitals. The map shows that terrorist events are predominantly concentrated in Asia, but Western countries, especially Spain and Germany, are also affected, sometimes by actions carried out by independentist movements (Spain's Basque autonomous community) and, in other European countries, by radical Islamist attacks (mainly knife attacks and bombings). The in depth analysis if each of 254 events summaries gives a till now unknown vision of the station inner places targeted by terrorist: public open

spaces in front of stations were attacked in 56% of the recorded cases, mainly by car bomb or murder shooting, rail infrastructures in stations in 24% of cases (e.g. bombs activated when the train was entering or leaving the station), and the interior of the building in 20% of cases (e.g. explosives placed in garbage cans or restrooms or suicide bombing).

Figure 1: Global patterns of terrorist attacks targeting railway station 2001-2017

Source: Authors and GTD Database

1.2. Station security gates: geographical and spatial patterns of implementation

9 As for any urban infrastructure, station vulnerability depends of two dimensions: the factors that determine the likelihood of an event happening and the capacity for response and resilience (Coaffee & Lee 2016). Reducing the risk of terrorism is not directly and not only a responsibility of rail operators, but is connected with a broad set of physical, technological, and organizational responses which have been developed in the last decades, as a security culture joins forces with a more traditional approach of rail safety culture oriented towards accident prevention (Jore 2019). Nevertheless, a growing catalog of measures designed to deter or prevent attacks is being developed and implemented: visible security with military or plainclothes patrols, dog teams, personnel with powers to carry out random luggage checks, CCTV, emergency phone boxes (International Union Railways 2017). Among the technological measures, especially in Europe where the rail industry is open to the market, and where station operators compete one with another and search for performance and quality of service, physical devices for the detection of weapons and explosives begin to be used here and there (Finger et al 2016). Of the different kinds of security gates, the most common is the airport system, with X-ray devices to check luggage and walk-through screening portals. Recent professional reports and research programs compiled in engineering sources (Matsuka et al 2018) provide an overview of the interest and propensity among rail stakeholders to incorporate these kinds of systems into their security strategies,

especially when big stations are directly connected to airports (Kaenwunruen et al 2018).

10 Nonetheless, the adoption of security gates is neither a general tendency nor a fast-growing trend. The authors explored the stations managers websites derived from figure 1 with the following methodology (table 2). The typology is based on an inventory of station plans made available on railway operators' websites or apps. Otherwise, architectural, technical or tourist information plans and photos were used when barriers were clearly visible. The limitation of the type of survey was to obtain up-to-date information. The scheme of terminal station form in figure 2 is also a simplification.

Table 2: Sources and sites used in the typology of access controls to railway station

	Example of Station	Country	Source	URL
[n°1] Station + District enclosure	Paris Gare de Lyon (13/11 /2015)	France	France Info (event)	https://www.francetvinfo.fr/faits-divers/direct-paris-la-gare-de-lyon-evacuee-en-raison-d-une-alerte-a-la-bombe_1173255.html
[n°1] Station + District enclosure	La Plaine-Stade de France (04/02 /2015)	France	RATP/SNCF	https://www.rerb-leblog.fr/evenements-au-stade-de-france-les-dispositifs-mis-en-place/
[n°2] Station door supervision	Moscow Kazansky (2016)	Russia	Google Image	https://goo.gl/maps/gAXbgDoDt5t7FneC7
[n°3] Railway and Service Area Diff.	Amsterdam Centraal	Netherlands	Civic Architects	https://www.civicarchitects.eu/projects/centraal-station-amsterdam
[n°4a] Modular subdivision (Partial)	Paris Gare du Nord (Eurostar)	France	Gare-du-nord.paris	http://www.gare-du-nord.paris/plan-gare-du-nord.php
[n°4a] Modular subdivision (Partial)	Genève Cornavin (Lyria)	Switzerland	SBB CFF FFS	https://www.sbb.ch/content/dam/infrastruktur/trafimage/bahnhofplaene/plan-geneve-plakat.pdf
[n°4b] Modular subdivision (Total)	Roma Termini	Italy	trenitalia	https://www.arketipomagazine.it/stazione-roma-termini-marco-tamino/
[n°5] Restricted access to gate	Paris Montparnasse	France	SNCF	https://www.garesetconnexions.sncf/sites/default/filesd7/field_plan_files/2019-05/hall_1_-_niveau_2.pdf

[n°5] Restricted access to gate	Paris Gare de Lyon	France	SNCF	https://www.garesetconnexions.sncf/sites/default/filesd7/field_plan_files/2020-01/pg-pgl_hall1et2.pdf
[n°6] Train door supervision	Union Station Torronto	Canada	gotransit.com	https://www.gotransit.com/en/the-future-go/improvements/union-station-revitalization
[n°6] Train door supervision	Gare de Vanves-Malakoff	France	SNCF Transilien	https://meslignesnetu.transilien.com/2019/03/13/vanves-malakoff-linstallation-des-rideaux-de-quais-va-debuter/

Source: Authors investigation

11 The results show heterogeneous patterns and variegated strategies in relation with security checks points and gates. For a small part of the group, security gates have been in use for a long time. This group includes Russia, China, Turkey, Saudi Arabia, California, and Brazil. For another part of companies, such systems have been adopted more hastily, in response to a high-profile terrorist incident. This is the case in Spain, where the 2004 bombings at Atocha station (193 dead) prompted ADIF to equip all its stations with luggage screening systems (despite the fact that the targets of the attacks were transit lines and hubs).

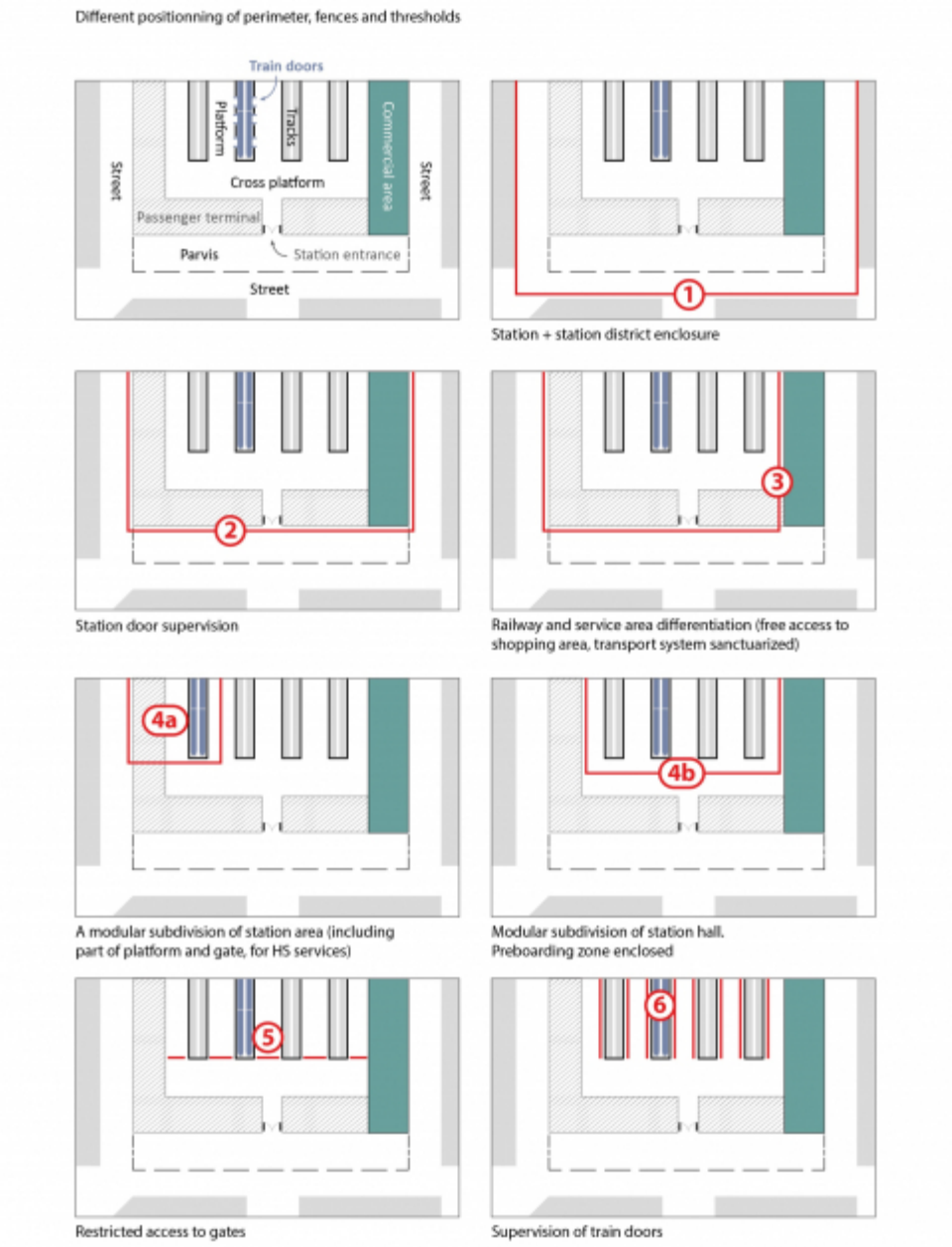
12 The station type (i.e. all stations, or small and medium-sized stations versus big stations, or high-speed versus non-high-speed stations), and the station design and construction date are two important parameters for understanding the way countries and railway operators adopt or don't adopt security checks and gates (Petroski 2004, Schulman and Roe 2007). Obviously, HS vs non-HS stations, transit vs non-transit vary in their capacity to host technical apparatuses, since they have different train boarding times and strategies (Harris & Anderson 2007). Our analysis shows that HS stations – particularly recent ones – are where there is the greatest presence in security checks, because boarding gates and security areas for boarding procedures were included in the terminal design phase. Elsewhere, the spatial layout of older HS terminal stations has to be rearranged to incorporate such technologies. This causes a real problem in European countries where stations were erected in the middle of 19th century with completely different passenger flow systems.

13 An example of the hesitation of national railway companies to implement security gates is offered in France and Belgium (both of which belong to the second group) in the aftermath of August 21 in 2015. This day, a man tried to open fire on passengers with a Kalashnikov in a Thalys HS train traveling from Amsterdam to Paris through Belgium but was overpowered by other passengers. A few months later, the Belgian rail company installed a dozen of barriers in summer 2017 at Bruxelles Midi, Anvers Central, and Liège Guillemin HS stations: the access to Thalys HS train was "enclosed" but the rest of train operations were open. The reaction of SNCF and French government was even more ambiguous. SNCF adopted after months of harsh political controversy 4 security checks and portals, while saying they were opposed to them, and while - at the same time - being actively involved in the installation of anti-fraud barriers to all trains (Paris Gare du Nord serves international HS, national HS, intercity, two types of regional trains and metro lines). France had no political and technical consensus about the necessity and capacity for security portals, although active benchmarking was carried out (Yoda et al 2018). Railway station operator advocated the specificity of station's space (built in 1857, the station has a very narrow concourse) and the great difficulties to reorganize flows and spaces in an already saturated place. Counterterrorism

programs (Bartolucci 2017) found themselves somewhat out in the cold, since both rail experts (Borrion et al 2014) and politicians (Fouché & Bonhomme 2016) took the view that more studies were needed before security could be incorporated into station design.

14 Before going deeper in the case study, this prompts a closer geographical vision of how security gates and ticket barriers can affect the size and internal/external spatial organization of stations, as well as surveillance practices (Castagnino 2016). Although the technologies are completely different, these two types of barrier have two things in common. First, they improve overall security and give passengers a sense of safety. Second, as physical thresholds, they have very significant impacts on station design and operation and on pedestrian flows. In a geographical attempt to understand their role in station flow management, they regrouped in one item and positioned in a standard station geometry with following spaces: the urban interface, the entrance and corridors, the main hall, retail facilities (retail areas may be considered as distinct from the main hall and entrance corridors), and platforms (in the figure, the station is considered as having no vertical dimension). Figure 2 is realized thanks to the collection of station maps of figure country 2 list. In model 1, the gates are located outside the station building, with the result that the terminal becomes an urban enclave. In the reality, this "enclosure" is never a permanent feature. Yet, territorially bounded security cordons around terminal stations may be temporarily installed as protection against car bombs during high-profile events (e.g. major sports fixtures) (Graham 2012, Coaffee 2014). In model 2, security (or ticket) barriers are installed at the entrance to the station (typically the case at Moscow's terminal stations). In models 3 to 4b, the terminal building is zoned, while access to the retail area remains free. Model 3 is in use in main Dutch terminal stations (exclusively for anti-fraud devices). Roma Termini inspires model 4: the station hall is zoned, with one free access, a glass barrier and a boarding zone filtered. In scenario 5, barriers or gates are positioned at the entry to platform: this solution is widely used for anti-fraud devices in France. In the last scenario, which has so far never been implemented, but remains as a possibility, a gate is located at the train door.

Figure 2: Access Control to railway stations: a typology



Source: Authors, from data in table 1

15 Apart from extreme models (1 enclosing the station, 5 enclosing the train), intermediate scenarios 2 to 5 are based on a partition of station and until now very few works give ex post analysis of the impact of such security gates on passenger flows and station activities (Li Y., Wu Y. 2017). That is why the authors searched to identify the geographical problems raised by such terminal zoning and the strategic - and even political - dilemmas they create for train service.

2. Case study at Paris Gare du Nord

2.1. Background

16 The station is Europe's biggest terminal (80,000 sq.m. open to the public), with more passengers than the world's biggest airport (SNCF open Data 2014), Atlanta Airport, though in terms of rail passenger numbers, Gare du Nord ranks only 23rd in the world (Collart Dutilleul 2018). Every day, more than 600,000 people travel on 1,200 metropolitan and regional trains and 147 long-distance trains, moving between five levels within the station. A surface level, 2 underground levels, and two staircases are accessible to public.

17 Paris Gare du Nord is both sensitive and symbolic in terms of security and the sense of security. It has to deal with crowding, stress, crime, and safety and security issues. It is perceived as a critical infrastructure and the security issues associated have been addressed by rail authorities and by public stakeholders (Bonnet 2009 Kleinman 2012). More than 6,000 security events per year occur in the station (2014, open data SNCF), ranging from passenger aggression, hawkers, and pickpockets to drug-trafficking, gang fights, ... and in 2015 attempted terrorist attacks. As the terminal links directly to sensitive and deprived areas in the northern Paris suburbs, Paris Gare du Nord is also a target of sensationalist press campaigns and speeches, particularly in election periods[1]. Populist politicians cite frequently Paris Gare du Nord while they whip up fears about immigrants. Paris's reputation for poor station security is regularly compared unfavorably by media with London's high-profile (and private owned) St Pancras (von Ferber et al 2012 and https://www.francetvinfo.fr/monde/europe/gare-du-nord-a-paris-vs-saint-pancras-a-londres-un-contraste-saisissant_995163.html). Security checks came to be cited as a possible solution to station security in this pre 2015 context.

18 The year 2015 was a dire year for terrorism in France, with 10 Islamist attacks and 154 deaths (though none at Paris Gare du Nord). The attack in Belgium on August 21, 2015 also in a sense concerned Paris Gare du Nord, since it is the terminus for the Thalys train. Less than five weeks after the Bataclan atrocity (November 13, 2015), the Secretary of State for Transportation ordered that security portals should be introduced by Christmas. On the eve of the Paris International Climate Conference, with a state of emergency in place and the terrorist risk at its maximum, 8 metal detector gates and 8 X-ray bag scanners were installed at the two Thalys platforms in Paris Gare du Nord following scenario 5 in the above typology. What did these devices change to station's micro geographical operation?

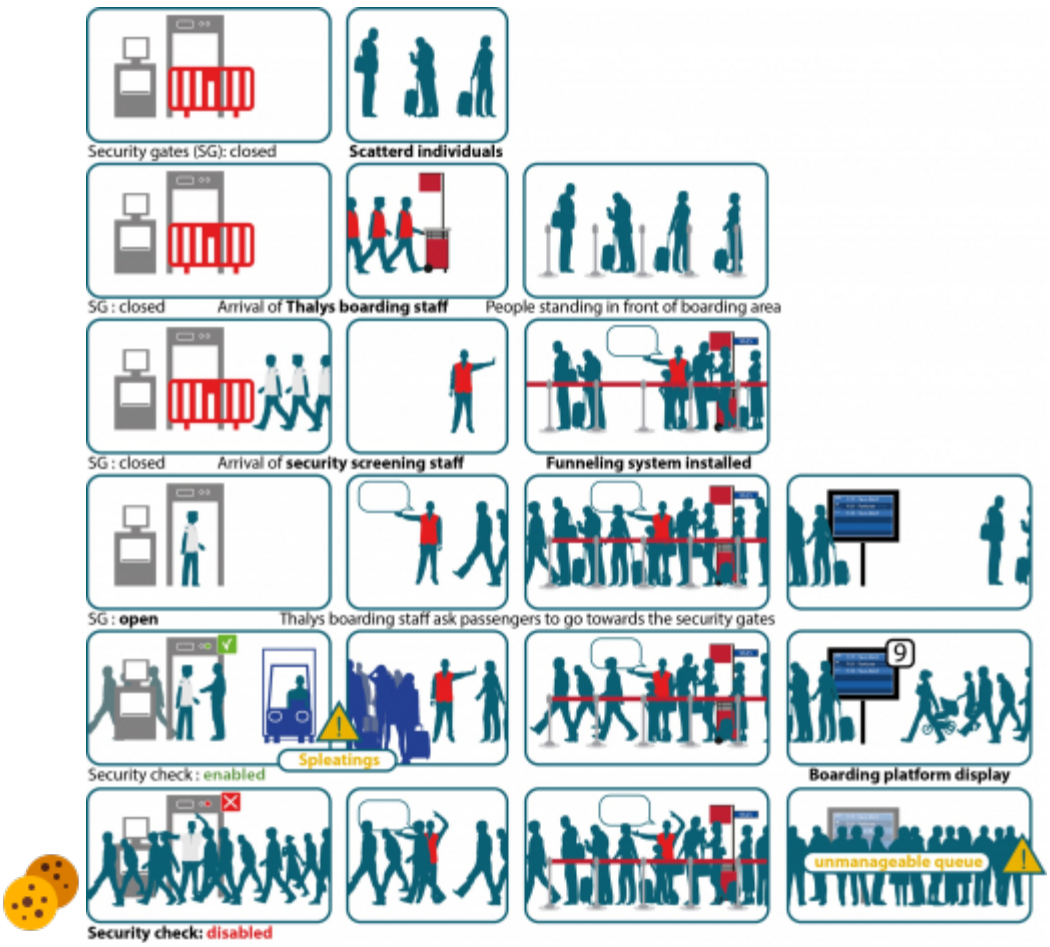
2.2. Methodology

19 Here is the empiric approach we faced on site. We have eye witnessed a number of problems, delays, conflicts in passenger flow and train boarding activities at a specific point of Paris Gare du Nord in front of Thalys trains. We understood that the operational response was depending on many factors, mainly the general affluence of station, the number of passengers queuing ... and we chose a panoptic observation site at the vertical of the scene, in order to be able to follow the totality of the boarding protocol minute after minute. Then we consolidated this empirical method after literature review (Matsika et al. 2016, Watson and Little 2016, Tang et al 2017) and stuck to it for two reasons. The first is that this type of method is easily implementable, without much delay and without on-site physical perturbation (the observer stays invisible to the passengers and the boarding operators). And this is important because of the station concourse was, at this time, heavily disturbed by works (the construction of a stair). The second reason is that CCTV network, which could have given access to more systematic and quantitative results on movements, was partially removed because

of this works and because the use of cameras for pedestrian flow analysis was at this time only in experiment. Yet, if the method is mostly based on qualitative data description, all the technical details of the survey is available in annex of the article (Annex 1).

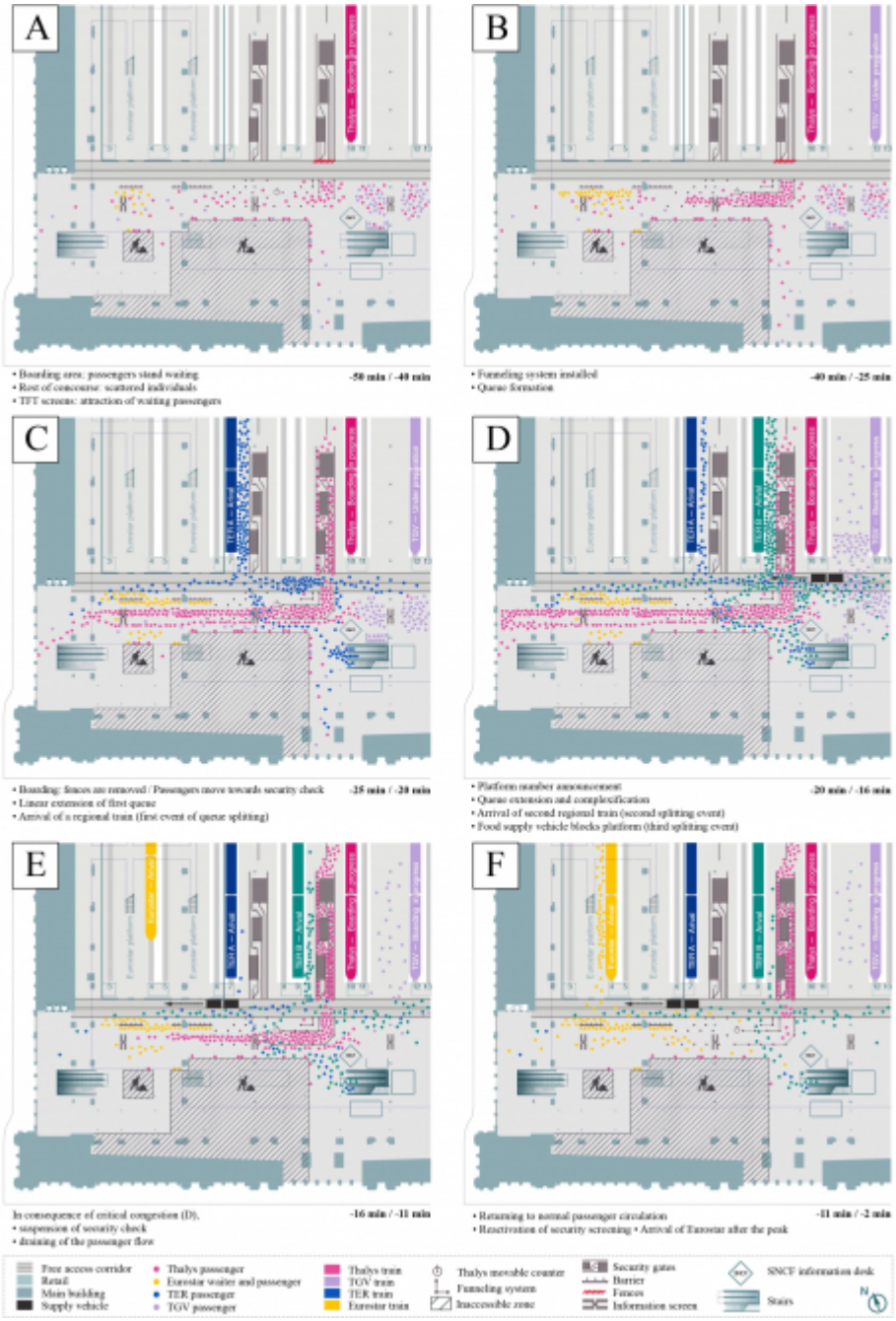
20 The implementation of the survey included all peak time Thalys train leaving Paris Gare du Nord for six days (from August 15 to September 5, 2018) and spread over 3 different days of the week. 55 departure check-in process were observed, half during the morning rush hour (7 and 10 a.m.), half during evening rush hour (5 to 8 p.m.). The authors followed in real time how boarding process adapted to flow congestion, with a special focus on the composition, location, length, and velocity of the Thalys boarding line. Attention was also devoted to the rest of station activity and to dynamic factors such as other train movements (Pasman & Kirilov 2017). Moreover, a Thalys Boarding Script (Figure 3) was designed by authors in order to understand the timing of a boarding operations. It shows that the process takes place into 5 steps. Firstly, a 4-person Thalys team, led by an individual who is always positioned at the head of the track, facing the crowd and with his back to the gates, shapes and orchestrates the flow line. His primary objective is to keep open the zone that runs at right angles to the tracks and is vital for rail operations, but also for visibility, safety, and security. At this time, gates are close when only few passengers gather in front of the platform. Once a few dozen of passenger group, the boarding staff arrives with mobile items and install funneling systems. The gates open only ten to fifteen minutes approximately before departure and the queue in invited to use it and go to train. Then, if problems occur, they block the file or, in most sensible moments, neutralize the gates and let people go to train with X-Ray device.

Figure 3: Thalys Boarding script: passenger queue formation and gate synchronization



Source: authors

Figure 4: Reconstitution of a problematic Thalys boarding operation



Source: Authors

21 A reconstitution was built on the basis of an operational incident witnessed on August 24, 2017 Paris - Brussels- Amsterdam train scheduled 8.25 AM because this particular moment was particularly delicate to operate (a D index as explained later in the text). Images A to F show the main steps taken to adjust the corridor for the line to move through the gates to the platforms, while minimizing conflicts between this line and other movements within the station. The Thalys train is pink and its passengers shown as pink dots. At moment A (one hour before departure), a dozen passengers are standing in front of the boarding area and the rest of the concourse is fairly empty. Moment B (about 40 minutes before departure) corresponds to the formation of the line. At moment C (30 minutes before departure time), movable barriers are put in place and the line grows. The shape of the line may be disorganized, e.g. when the

arrival of a regional train (in blue) at another platform splits the flows. The announcement of the platform number, about 20 minutes before departure, prompts people to gather in front of the Thalys platform, resulting in a lengthening of the line. The arrival of a second regional train (in yellow) takes the concourse to congestion level. A critical congestion point is reached (moment D) and security checks are therefore suspended in order to let people flow, so that this part of the station hall is cleared (this decision also avoids a delay in departure). After peak flow (moment E), when the crowd of passengers has thinned, security checks resume for a few minutes and the remaining passengers are screened. Such field observation shows clearly the difficulty of combining flow management with security screening. Is this situation exceptional? What type of flow conflicts occur and to what extent do they disrupt the whole boarding process?

2.3. Assessing pedestrian flow conflicts on time and exact location

22 An aggregate index of flow is developed in the table 3. Six types of conflicts are observed during the boarding process (column 1), some caused by line splitting (type 1), others by congestion (type 2 to 6). Each conflict is scored on a scale from 1 to 4 (column 2 to 5), in terms of its duration, intensity (i.e. degree of disruption of the boarding process), location and cause (Table 3). The length and shape of the line is photographed and measured at two-minute intervals (figure 4).

Table 3: Construction of aggregate index

	Disruptions in the boarding process	Disruptions in movement in station	Aggregate index	Effect on security gate use
Level A Situation fully under control	uneven progress of passengers in the line supply wagon crossing the line simply slows progress	no disruption, coexistence between the Thalys line and general station operations	temporary and short-lived splits or diversions that do not threaten the effectiveness of the service	Gate + Scanner checks operational
Level B Situation of conflict management	momentary interruption of boarding to allow other operation (e.g. to allow passengers off another train)	acceptable disruption, Thalys line and waiting passengers bypassed by small groups outside the line	splits and diversions sufficiently frequent or prolonged to delay or interrupt boarding	Gate + scanner checks operational
Level C Situation of disruption	Need for intervention by a boarding operative (physical movement to a point in the line to organize a diversion, movement of a line control barrier)	Thalys line starts to cause problems for station operations: travelers unable to access an information screen, escalator, or information booth	conflict with sufficient impact to require technical intervention (personnel intervention to resolve a conflict)	incomplete security checks. Some passengers exempted from checks to accelerate flows and prevent congestion

Level D Emergency situation, “out of control”	Service ineffective: boarding impossible and emergency response required	total collapse of the line structure which breaks up into multiple lines and is absorbed into the mass of people in the station	general blockage: Thalys boarding point prevents other train boarding and paralyses station movement	no passenger security checks. Security scanners disarmed to relieve station congestion

Source: Authors

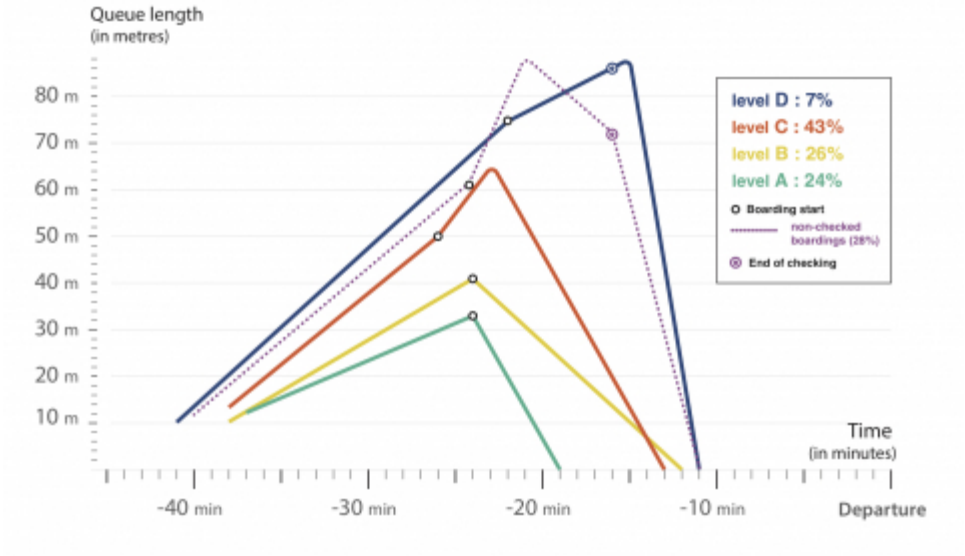
3. Results and discussion

3.1. Result 1: Security gates create congestion

23 Figure 5 explains how the boarding team readapt the script at every moment in the attempt to balance the operation of Thalys line (e.g. immobile and slow-moving individuals) and the affluence of the station.

- Level A (24% of boardings) is a favorable scenario because the station is relatively empty and the train itself not full. Boarding is managed smoothly. The line does not grow to more than 30 meters (often less) and security checks are in operation throughout the process.
- Few temporary incidents occur in a level B type boarding (26% of cases). The security gates slow the process to an acceptable degree. Pedestrian movement around the station may split the Thalys line but this does not present a risk to station and train operation.
- At level C (43% of boardings), the boarding team judges that the combination of the two waves has reached a critical point and takes the decision to halt the security scanner for a few minutes, in order to clear the concourse and speed up the flow. This scenario was presented Figure 4. If security performance is reduced due to the deactivation of the luggage scanner, Thalys stewards raise the level of visual surveillance.
- The D level scenario (7% of boardings) occurs when the line extends to more than 90 meters (it represents about 600 people, a full train. In scenario D, the Thalys line is so long that it merges with the cab rank line outside the station. The line fuses into a chaotic crowd that impedes the boarding process and creates safety problems (e.g. for fire emergency evacuation) as well as vulnerability to terrorism (Cox and Griffiths 2006). At this point, the security gates are definitively deactivated, and passengers are invited to board the train directly.

Figure 5: Thalys Line length at some moments in the boarding process



Situations C and D occur when several bad conditions and operation incidents cumulate. Along these, the train capacity (Thalys uses coupled trains with more than 700 seats), the train rate occupancy, the general operation system of the station (high-speed or regional lines are running on adjacent platforms and a mass of people alight). In the worse cases, an incident occurs (e.g. delay in the boarding of another train, with the result that there is a buildup of waiting passengers on the concourse).

Source: Authors

3.2. Result 2: Gate deactivation is still a security choice

24 This specific study demonstrates that the decision to deactivate the security scanner is made when no other option is available, and the intention is to minimize risks. The security scanners are deactivated temporarily (case C) or definitively (case D) in 50% of boardings (C+D). This seems to be the only way to release the pressure and, at the same time, the best preventative measure against terrorist attack. It is therefore a sound security choice. Thalys personnel take an adaptative approach to boarding, since team leaders continually need to negotiate a variety of dynamics: the balance between the fluidity of the crowd in the station hall and the speed of the line through the security gate, and the time available before train departure. At every moment in the process, the decision to maintain or deactivate the security gates depends on the perception of crowd controllability.

3.3. Fluidity and openness or confine and block? Two visions of station design

25 The case study corresponds to a very specific case which can difficultly be generalized, given to several reasons. The works on the platform prevented temporarily to let the queue develop on the platform. The season of observation was late summer, and this period of holidays conducted to high occupancy of Thalys trains. Another element is that the security measures were implemented a few months before and were made compulsory for boarding agents who had to adapt and were still experimenting the best way to adapt the boarding script. Yet, even if it is difficult to generalize from the case study, this analysis illustrates some key questions that station managers have to address

in other stations, in different contexts.

26 Overcrowding caused by poor gate location may create safety problems, e.g. emergency evacuation difficulties (Wei et al. 2012) and security problems, e.g. increased vulnerability to terrorist attack (Zio 2016). In existing stations, the effectiveness of security devices depends on their spatial integration and interaction with station operations. But is there a threshold, in very busy nodes, where gating begins to be more a problem than a solution?

27 There is no consensus on this issue. The security industry, eager to sell security devices, advocates for terminal station boarding procedures to be aligned with airport practices, both technically and methodologically. Following Hoitjink, who, as a sociologist, has collaborated with railway and security stakeholders and adopted a critical eye on their construction of problem, the security industry commonly understates the impact of security gating on flow management and safety and security in stations because of commercial interests (Hoitjink 2015). On the opposite, numerous security experts and urban scholars want to maintain stations as freely accessible environments. Each have many different reasons. For some of them, it is a problem of performance: the overall performance of stations and transportation hubs depends on their fluidity, and the real problem is to implement control facilities with minimum effect on passenger flows (Collart Dutilleul 2018, Asmer et al. 2019). Geographers take the view that the spatial fragmentation of stations into different zones caused by security barriers can have a serious impact on some of their urban functions, and some consider that trade-offs need to be made between security and attractiveness (Loukaitou Sideris 2006), as a gated station is less functional (that is to say it gives less access to railway services, to shops, etc.).

28 This discussion offers a final clue to the reasons for such misguided choices. In Paris Gare du Nord, security devices play evidently a preventive and dissuasive role with respect not only to terrorism, but to robbery, crime and public space fears (Kaufmann 2016). Checks and gates are "*political technofixes*" (Hoijtink 2015) and represent the physical part of the State "*security narrative*" (Duijnhoven 2010). In 2015, the French people's demand for public space security was so high that transportation security was taken out of the hands of experts and from train operator. This kind of political response was immediately denounced as such by associations and governmental commissions (Bonhomme et Prouvé 2016). Security gates, in this case, were a more than technical solution, implying another ambiguous balance between calming effects and security impacts.

Conclusion

29 This paper began with an overview of terrorist attacks on railroad stations and offered evidence of the increase in such incidents. A preliminary analysis identified the conditions under which walk-through security gates and x-ray luggage scanners were introduced into the spatial design of stations and showed multiple spatial patterns of stations securitization, depending on the volume of the station building and on the arrangement of waiting zones, corridors, service areas and trains lines and platforms. Then, it drew on a case study to show that problems arise when railway companies have to adapt existing terminal stations to the implementation of such gates after a terrorist attack, and with not much time to consider the best way to proceed.

30 The investigation was conducted using empirical data compiled after having eye-witnessed more than 50 boardings and mapped, in real time, queue formation, flow congestion and conflicts, boarding team channeling activities and security decisions.

This survey demonstrates that station security and flow management are fundamentally linked. In the case of Paris Gare du Nord, there is a problem of compatibility between high pedestrian density on the concourse and the line formed before the gates. The result is that portals affect global security in the station and make it necessary to deviate from the official security script. Here is an illustration of how a "managed security culture" that depends more on the skills and cognitive capacities of supervisory personnel on the ground than on top-down directives is mobilized and replaces a procedural approach to security.

31 The article ends with controversies amongst academics and experts over the potential and limitations of security gating in stations. It explains that the security industry is pressing for the implementation of security gates in railway environments, and that the political context must be also considered when examining the introduction of security procedures in terminal stations. taking the Paris Gare du Nord as a non reproductible case, but a paradigmatic situation, it raises the question of the adequacy and the proportionality of the response of governments after 2015 terrorist attacks (Coaffee 2017).

32 As a conclusion, the authors advance that a "confine and block" approach to terminal station security is not necessarily the best solution in busy transit stations that already experience structural congestion. However, the debate is regularly reopened, either following high-profile terrorist attacks, or when mega-events (such as the Olympic Games scheduled to take place close to Paris Gare du Nord in 2024) lead to radical experimental initiatives in hub security.

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Notes

1 A controversy was reopened after right-wing deputy Nadine Morano, (former Minister during Sarkozy's mandate), declared "*La Gare du Nord, c'est l'Afrique*" a few months after Thalys attack. She pointed altogether at the presence of concentration of migrants in and out of the station, bad transport service and delays after train exploitation incidents, security problems (rapes, thefts). https://www.lepoint.fr/politique/nadine-morano-la-gare-du-nord-c-est-l-afrique-22-05-2016-2041189_20.php

List of illustrations

Title	Figure 1: Global patterns of terrorist attacks targeting railway station 2001-2017
Credits	Source: Authors and GTD Database
URL	http://journals.openedition.org/cybergeo/docannexe/image/35341/img-1.jpg
File	image/jpeg, 380k

Title	Figure 2: Access Control to railway stations: a typology
Credits	Source: Authors, from data in table 1
URL	http://journals.openedition.org/cybergeo/docannexe/image/35341/img-2.jpg
File	image/jpeg, 860k

Title	Figure 3: Thalys Boarding script: passenger queue formation and gate synchronization
Credits	Source: authors
URL	http://journals.openedition.org/cybergeo/docannexe/image/35341/img-3.jpg
File	image/jpeg, 948k

Title	Figure 4: Reconstitution of a problematic Thalys boarding operation
Credits	Source: Authors
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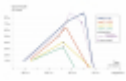

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Credits	Source: Authors

URL	http://journals.openedition.org/cybergeo/docannexe/image/35341/img-5.jpg
File	image/jpeg, 546k

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