Siting of Safe and Secure Truck Parking Areas in Greece and definition of their security level with the use of Multi-Actor Multi-Criteria Analysis (MAMCA)

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Abstract. The purpose of this paper is the siting of safe and secure truck parking areas in Greece and the definition of their security level. The increase of road freight transport, and the need for the strengthening of its safety, led to the need for developing a plan for the deployment of safe and secure Heavy Goods Vehicles (HGVs) parking areas. A demand and supply survey led to the development of a plan to address 29.83\% of the total demand. Nine (9) stakeholder groups, represented by twelve (12) participants, participated in a Multi-Actor Multi-Criteria Analysis (MAMCA) of the criteria evaluation for choosing the most suitable security level out of the following levels: Bronze, Silver, Gold, and Platinum, for Aigio’s Rest Area. The Platinum level was commonly chosen as the most appropriate.

1. Introduction

Heavy Goods Vehicles (HGVs) parking areas are the most vulnerable elements of road freight transport since the problem of criminals targeting HGVs in parking lots is constantly increasing. The availability of safe and secure parking areas for HGVs is essential both for efficient freight transport and for compliance with European regulations. Numerous scientific papers \cite{1,2,3,4} and European research projects, such as the “Secure European Truck Park Operational Services” (SETPOS) project \cite{5} and the “Creating a Label for (Secured) Truck Parking Areas along with the Trans-European Road Network and Defining a Certification Process. Including Online Information Facility” (LABEL) project \cite{6}, have highlighted the need to increase the safety and security level of the existing ones.

A study on the real-time routing of HGVs revealed that the high risk of drivers’ fatigue could be prevented by properly organizing the working time and the adequate long rest periods \cite{7}. Despite the common acknowledgment of the lack of adequate parking areas and the European Commission’s efforts to promote safe parking solutions \cite{5,6}, the processes for constructing and managing parking lots for HGVs are unclear, with many variations by country \cite{1}. The lack of adequate parking lots for HGVs and the mismatch between available facilities and parking lot demand is a global concern \cite{2}.

An investigation of the parking situation in the United States of America (USA) proved that the problem of HGVs parking is directly related to the increase in freight transport in the USA \cite{2}. The theft of transported goods is one of the main problems in road freight transport \cite{8}.
According to a European Parliament’s publication [9], the road freight transport annual losses due to thefts amount to €8.2 billion per year: around 40% of thefts occur while driving, 40% in parking lots, and 20% in roadside parking stops. A latest study revealed that at least 37% of total thefts take place when the cargo is not moving [10]. The theft problem in Greece alarmingly has not been recorded, but there are several vulnerabilities in parking security, according to drivers’ testimonies.

2. Background

2.1. European legislation for HGVs parking areas

The following European legislation directives and regulations are related to the development and exchange of information for Safe and Secure Truck Parking Areas (SSTPA): Directive 2008/96/EC on road infrastructure safety management stated that sufficient safe parking areas should become an integral part of road infrastructure safety management [11]; Directive 2010/40/EU on the framework for deployment of Intelligent Transport Systems (ITS) in road transport sets as a priority the provision of information services and the provision of reservation services for safe and secure parking places for trucks and commercial vehicles [12]; Regulation (EU) No. 165/2014 on tachographs in road transport, repealing Council Regulation (EEC) No. 3821/85 on recording equipment in road transport and amending Regulation (EC) No. 561/2006 of the European Parliament and of the Council on harmonization of social legislation relating to road transport [13]; Regulation (EU) No. 885/2013 with regard to the provision of information services for safe and secure parking places for trucks and commercial vehicles, which is supplementary to the ITS Directive 2010/40/EU and highlights the importance of SSTPAs in combating and preventing road freight crime [14]; and Guidance Document for Member States on technical implementation of Delegated Regulation 885/2013 (2016) in relation to the European Access Point for Truck Parking Data. This Guidance Document clarifies the steps for the successful implementation of the Commission Delegated Regulation (EC) No. 885/2013, which clarifies the data collection for the HGVs parking areas, as it defines the exact naming of the related data and the type of information, according to Datex II [15].

2.2. Security and service levels

In developing a rating system for parking facilities, it is necessary to note that there are different kinds of users and different situations with regard to the security level needed. The following four security levels have been defined: Bronze, Silver, Gold, and Platinum [16]. Security is assessed by establishing security features and measures at the perimeter, the parking area, the entry/exit, and through staff and management procedures. The security levels build on one another so that, for example, the Silver standard includes all the requirements for Bronze, and so on [16]. Further to the security requirements, a basic service level must always be reached (e.g., there are toilets, showers, and washing facilities that are clean and checked regularly, there are water taps, waste bins, and clear signs for safe traffic movement, emergency contacts are displayed, snacks and drinks are available for purchase, there is Internet connection and electricity, it operates 24/7, etc.) [16].

3. Methodology and implementation

Siting of SSTPAs is a complex problem that can be solved on the basis of a literature review and evaluation of supply and demand data for safe and secure HGVs parking lots. The methodology for proposing the siting of SSTPAs included the collection of all available data, i.e., data for the Greek Motorway Network, legislation limitations and requirements for HGVs parking areas in Greece, demand and supply data for HGVs parking, and the data processing through a demand and supply approach to meet the national needs. Multi-Agent Multi-Criteria Analysis (MAMCA) was used for choosing the security level of a specific SSTPA as a pilot application.
3.1. Siting of SSTPAs

3.1.1. Limitations. From the literature review [1][3][7][8][18][19][20] and the study of the relevant legal framework [11][12][13][14][15], it has been found that SSTPAs are essential for the safe transport of transported goods, and in accordance with the Directive 2010/40/EU of the European Parliament and of the Council, there should be an SSTPA in every 100 km of the Trans-European Transport Network (TEN-T) [12]. The Greek Motorway Network is part of the Orient/East-Med Corridor, which connects large parts of central Europe with ports of the North, Baltic, Black, and Mediterranean Seas. The Orient/East-Med Corridor focuses upon fostering the development of these ports as major multimodal logistics platforms, providing, thus, economic centers in central Europe with modernized, multimodal connections to the Motorways of the Sea [17]. The data for the Greek highways which belong to the Orient/East-Med Corridor of the TEN-T network were collected from Hellenic data sources [21].

3.1.2. Demand Data. According to demand data on SSTPAs, a total of 5,229 parking lots per night are expected to be needed [13]. Table 1 shows both the demand for parking lots per night in Greece and the EU-28 area. In fact, demand for overnight parking lots in Greece represents 1.32% of the total demand in the EU-28 area.

Table 1. Overnight Parking Demand for Greece and EU, 2015 Basis [22].

| Area  | All Commodity Categories, 2015 | Medium-High Value Segments Value > €3/Kg, 2015 | High-Value Segment Value > €10/Kg, 2015 |
|-------|-----------------------------|-----------------------------------------------|--------------------------------------|
| Greece| 5,229                       | 711                                           | 143                                  |
| EU-28 | 395,674                     | 85,417                                       | 26,276                               |

The demand data derived from the extended analysis, which was based on: the goods traffic flows on 2015 traffic data, the long-distance goods flows, the road haulage speeds, the road haulage trips, the share of long-distance traffic, the main logistics freight demand “hotspots” and Roll-On/Roll-Off (RO-RO)/ferry ports, and the cargo crime incidents [22].

3.1.3. Supply Data. The supply data were collected for the existing service stations located on the Greek Motorway Network, as well as the parking areas recorded in the European databases on SSTPAs, namely Truckfly [23] and TRANSPark dataset [24]. These data were mapped and represent the existing parking areas for HGVs in Greece. Table 2 shows the service stations in the Greek sections of the Orient/East-Med Corridor of the TEN-T network. In Table 2, the length column shows the lengths of the road segments and a specific code next to them. The code letter “P” comes from the word “parking,” thus giving a unified sort-numbering which later on will be used for mapping the supply.

Apart from the existing service stations located on the Greek Motorway Network, which are not certified or labeled as SSTPAs, the supply analysis includes all parking areas which have been recorded in the European databases. The investigation for finding Greek recognized SSTPAs was made with the use of different data sources: i.e., European Secure Parking Organisation (ESPORG), TRANSPark (International Road Transport Union [IRU]), Truck Parking Europe (Planung Transport Verkehr Group [PTV Group]), TransParking (Trans.eu platform) and Truckfly (Truckfly SAS) applications [22]. The data were mainly retrieved from the TRANSPark dataset, which uses the LABEL certification system for the certified parking areas. Thus, eight (8) more parking areas for HGVs were added to the previous list: Euro parking (P2), which is located in Thessaloniki and has 120 parking lots; Olympus Plaza Food Parks (P4), which is close to the city of Katerini and has 30 parking lots; Shell Tasioulas-Filippou (P14), which is accessed from E90 Ioannina-Kozani, is close to Eleousa,
and has ten (10) parking lots; Nikolaou Eirini (P15), which is located on the Ioannina-Igoumenitsa National Road; Olympus Plaza Antirrio 1 (P20), which is close to Antirrio and has 20 parking lots; Olympus Plaza Schimatari 2 (P9), which is close to Schimatari and has 20 parking lots; Tripark (P27), which is close to Kounoupitsa and has 80 parking lots; and Olympus Plaza Athens International Airport (P13) (permanently closed), which is located at the Athens International Airport “Eleftherios Venizelos.”

### Table 2. Service Stations in Greek sections of Orient/East-Med Corridor.

| Highway code | Motorists Service Station (MSS) Name and Length |
|--------------|-------------------------------------------------|
| A1           | 1. Polykastro – 465 km A1 (P1), 2. Korinos – 447 km A1 (P4), 3. Skotinas – 410 km A1 (P5), 4. Evangelismos – 373.6 km A1 (P6), 5. Almyros – 269 km A1 (P7), 6. Atalantis – 144+200 (kilometric position) A1 (P8), 7. Schimatari (Tanagra) – 70+700 (kilometric position) A1 (P9), 8. Malakasa (Seiros) – 47+875 (kilometric position) A1 (P10), 9. Kapandriti (in one direction to Lamia) – 36+455 (kilometric position) A1 (P11), 10. Varympompi (Agiou Stefanou) (in one direction to Athens) – 24+535 (kilometric position) A1 (P12) |
| A2           | 1. Platanos – 283.5 km A2 (P3) |
| A5           | 1. Episkopiko – 194+870 (kilometric position) A5 (P16), 2. Amvrakia (in one direction to Ioannina) – 154+130 (kilometric position) A5 (P18), 3. Antirrio (in one direction to Antirrio) – 100+560 (kilometric position) A5 (P20), 4. Filippiada – 86+215 (kilometric position) A5 (P17), 5. Evinochori – 27+182 (kilometric position) A5 (P19) |
| A8           | 1. Psathopyrgos – 198 km A8 (P21), 2. Aigio – 175 km A8 (P22), 3. Akrata – 152.5 km A8 (P23), 4. Kiato – 103.6 km A8 (P24), 5. Korinthou – 94 km A8 (P25), 6. Megara – 40.5 km A8 (P26) |

3.1.4. Comparing demand and supply

The main aim of proceeding with the demand and supply analysis is the comparison between the data of the analysis and, finally, the identification of potential areas in the Greek sections of the Orient/East-Med Corridor of the TEN-T network with recognized undersupply of parking areas and the proposal of a national plan for the deployment of new SSTPAs. Regarding the recognized undersupply of parking areas in Greece, the main needs for secure HGVs parking lots were observed in locations where the greatest demand is located, i.e., in Athens and Katerini, and then Serres (which borders Bulgaria), Kythira and in the areas of Poros, Methana, Aegina, and Salamis, while some uncertified but sufficient parking lots exist in Athens, Ioannina, Katerini, and north of Chalkis. All of these parking lots are on the Orient/East-Med Corridor of the TEN-T network [13]. It is worth highlighting that there are only eight (8) parking areas recorded in EU databases, and they have in total 304 parking lots for HGVs. These cover only 3.8% of the total demand in overnight parking lots. Based on the final supply analysis, which also includes the service stations of the Greek Motorway Network, the total number of parking lots (885 parking lots) represents 16.9% of the total demand in overnight parking lots.

3.2. Multi-Actor Multi-Criteria Analysis (MAMCA)

The Multi-Actor Multi-Criteria Analysis (MAMCA) is a decision-making method to enable the simultaneous evaluation of alternative policy measures and scenarios while explicitly including different stakeholders’ opinions at an early stage of the decision-making process. MAMCA consists of seven steps [25]: definition of the problem, which is the security level of Aigio’s Rest Area (step 1). Then, a stakeholder analysis mapped all relevant stakeholder groups and identified their objectives, i.e., Stakeholder 1 (S1): Truck Drivers, S2: Logistic Companies, S3: Shippers, S4: Truck Parking Owners and Managers, S5: Insurance Companies, S6: Port Security Managers, S7: High-Level Transport Experts, S8: Highway Managers, and S9: Transport Engineers (step 2). Thus, nine (9) stakeholder groups, represented by 12 participants, participated in the MAMCA analysis.
The objectives were translated into simpler criteria, and each stakeholder group weighted the importance of these criteria. At the same time, an online weighting survey was launched for the stakeholders (step 3). The 9point-Saaty’s-scale was chosen to measure the performance of a scenario for its effect on a specific criterion (step 4). After that, experts evaluated the scenarios based on their performance measured by the qualitative method (slight/significant contribution, etc.) (step 5). In the 6th step, the MAMCA software produced a ranking of scenarios for each stakeholder group. These results were discussed with the stakeholders, and the outcome of the evaluation process was presented and discussed (step 7).

4. Results and Discussion

Based on the main findings from the demand-supply analysis, two different and realistic scenarios were determined for making a step closer to the balance of the demand-supply in SSTPAs. Beyond the need to balance the demand and supply, there is always the need to comply with the EU legislation and developing certified parking areas for HGVs, according to the newly proposed four-security level labeling system: Bronze, Silver, Gold, and Platinum [16].

4.1. Scenario 1

The 1st Scenario builds upon the main consideration of taking advantage of the existing parking areas for HGVs and existing service stations and proposes the development of at least five (5) new parking lots for HGVs in each parking area. This could be achieved by extending the existing parking or converting parking areas for private passenger vehicles to parking lots for HGVs. If at the same time, these areas become suitable for overnight HGVs, then there will be a total of 1,080 overnight parking.

4.2. Scenario 2

The 2nd Scenario also builds upon the main consideration of taking advantage of the existing parking areas for HGVs, and specifically, this scenario adds to Scenario 1 some additional parking areas for HGVs, thus ensuring the compliance with the Directive 2010/40/EC of the European Parliament and of the Council. The distances between the existing service stations and the recorded parking areas are almost all less than 100 km. Two main exceptions are recorded based on the supply data. The 1st exception is the case of Egnatia Motorway, which has only one recognized service station in the segment we are considering. The distance between Platanos (P3) and Shell Tasioulas-Filippou (P14) is 226 km, and the distance between Platanos (P3) and Episkopiko (P16) is 221 km. Thus, two (2) additional safe and secure parking facilities will be needed to be constructed in Egnatia Motorway. These new parking facilities are proposed to be in the two directions of the motorway, and so the development of four (4) new parking areas in the Egnatia Motorway area is proposed. Suitable lands will have to be found in order to accommodate 40 parking lots for HGVs/parking facilities. Thus, the total number of overnight parking areas will reach the number of 1,240 parking lots. A second exception is the case of the A25 motorway that connects Thessaloniki with the Greek-Bulgarian border. This motorway has no parking for HGVs. Specifically, the distance between the Platanos (P3), near the A25 motorway, with the Greek-Bulgarian border is approximately 150 km. To be fully harmonized with the Directive 2010/40/EC of the European Parliament and of the Council, this case also will need two (2) new safe and secure parking facilities, which would have to be constructed on the A25 motorway. Based on the previous considerations and addressing the high demand in this region [22], four (4) new parking areas on the A25 motorway are proposed in order to supply a sufficient number of parking lots for HGVs. Suitable lands will have to be found in order to accommodate 80 parking lots for HGVs per parking area. By allocating four (4) additional parking facilities solely for the use of HGVs, the total number of parking spaces per night will reach the number of 1,560 parking spaces.
Figure 1. Number of parking lots for: existing supply data in parking areas, supply data for Scenario 1, and supply data for Scenario 2.

Figure 2. Supply and demand of parking lots for: existing supply data in parking areas, supply data for Scenario 1, and Supply data for Scenario 2.

Figure 3. Evaluation of the alternatives for all stakeholders with MAMCA.

Figure 1 shows the change in supply when adapting the proposed Scenarios solutions. In Figure 1, the difference in parking lot numbers for HGVs is shown for each parking area. Figure 2 shows both the demand in overnight parking lots for HGVs and the existing supply, the supply when adopting the 1st Scenario, and, finally, the supply when adopting the 2nd Scenario. The first point to be highlighted is the high unbalance between the demand and supply in the three (3) different supply cases. It is encouraging that both realistic proposals (Scenario 1 and Scenario 2) lead to the increase of the supply and move towards the equalization of the demand-supply in overnight safe and secure HGVs parking lots. In the 1st Scenario which included soft interventions in the existing service stations and parking areas, this share was increased up to 20.65%. Although the 2nd Scenario covers all the needs for proper distribution of SSTPAs according to the Directive 2010/40/EC of the European Parliament and of the Council, the number of parking lots are not yet sufficient, since the new coverage in the total overnight parking demand was only increased up to 29.83%.

4.3. Definition of the security level

Figure 3 shows the results of the evaluation of the four (4) different alternatives, i.e., Bronze, Silver, Gold, and Platinum, for the security level for Aigio’s Rest Area. The purple lane representing the 4th level of security (Platinum Level) is higher than the other three (3) levels for the nine (9) stakeholder groups. The choice of the alternative to the problem addressed is clear, i.e., Aigio’s Rest Area should proceed with all the necessary security measures to meet the needs of a Platinum Level parking area.
5. Conclusions
All the considerations of this study have been analyzed to increase awareness of the parking needs for HGVs. The high unbalance between the demand and supply of overnight parking lots for HGVs is difficult to be equalized due to the lack of funds and free lands to develop safe HGVs parking facilities. This research could be the basis for developing a national plan to deploy safe and secure HGVs parking areas. Adopting Scenario 2, coverage of 29.83% of the total demand in overnight parking lots will be achieved by a 12.91% increase of the initial condition, which includes a total number of 885 parking lots. The need to increase security on freight transport is more urgent than ever, as increased freight transport traffic leads to a steady increase in thefts. SSTPAs is the 1st listed measure and priority for addressing criminality in freight transport. Having proposed a plan to meet as much demand as possible in SSTPAs, MAMCA was used with the aim of deciding on the level of parking security in one of the parking areas. From the implementation of MAMCA and the prioritization of alternatives, it seemed that the stakeholder groups agreed on the “Platinum Level.”

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