

# Dissertation - Mark Toro

*by* Mark-Walter Toro

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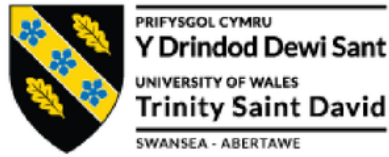
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# **Dissertation**

**An explorative multi-method study into waiting times affecting freight transportation when entering Schengen at a Romanian-Hungarian border**

Dissertation (M6X01293)

BSc (Hons) Logistics and Supply Chain Management

Supervisor: Graham Orr

Student: Mark - Walter Toro (P144670)

## **Appendix 1: DECLARATION**

I, Mark – Walter Toro, declare that I am the sole author of this dissertation; that all references cited have been consulted; that I have conducted all work of which this is a record, and that the finished work lies within the prescribed word limits.

This has not previously been accepted as part of any other degree submission.

Date: 14/05/2018

## **Appendix 2: FORM OF CONSENT**

I, Mark – Walter Toro, hereby consent that my dissertation, submitted in candidature for the BSc (Hons) Logistics and Supply Chain Management degree, if successful, may be made available for inter-library loan or photocopying (subject to the law of copyright) and that the title and abstract may be made available to outside organisations.

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## **Abstract**

This paper produces a case study on freight transportation at Bors – Artand (B-A) border crossing point (BCP) at the Romanian and Hungarian border. As both states are members of the European Union but only Hungary is part of the Schengen Agreement, border controls apply which inevitably generate an impact on logistics activities. One of the impacts discussed in this study are waiting times (WTs) which can result in supply chain bottlenecks, affects the mobility, delaying the provision of services and the delivery of goods simultaneously. This study attempts to discover the lengthiness of these WTs occurring at this BCP. In order to accurately investigate it, three sources are considered which concurrently facilitates data triangulation. The first is provided by a survey on WTs at B-A BCP registered in a period of five months. The second perspective is shaped by surveying 171 truck drivers about WTs and essential matters. Ultimately, based on prior research, the Trade and Transport Facilitation in Southeast Europe (TTFSE), Miltiadou et al. (2016) and Romanian Border Police (RBP) key performance indicators (KPIs) form the third perspective. The survey identified that average crossing times from Romania to Hungary profoundly differ from crossing times from Hungary to Romania. Furthermore, the longest WTs occur between 12:01-18:00 and 18:01-23:59 on Wednesdays and Tuesdays. The questionnaire revealed that lorry drivers consider infrastructure problems as one the primary reasons for delays at this BCP. Moreover, they have suggested that corruption largely plays a role of who becomes exempted from waiting in the queue. Additionally, statistical tests revealed that for specific loads priority is not accorded, as it should be. However, these responses are carefully evaluated, considering various aspects, which may have influenced the drivers' opinion.

The survey, the questionnaire and the literature review added value to this study in a unique way, which not only draws a picture of this BCP but highlights the impact of WTs. Additionally, this paper intended to explore solutions of how contemporary border crossing can be improved. By addressing this important gap in current knowledge, this paper seeks to add value to the understanding of future freight transportation through gaining and increasing awareness in a multi-method study.

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## **Chapter 1. Introduction**

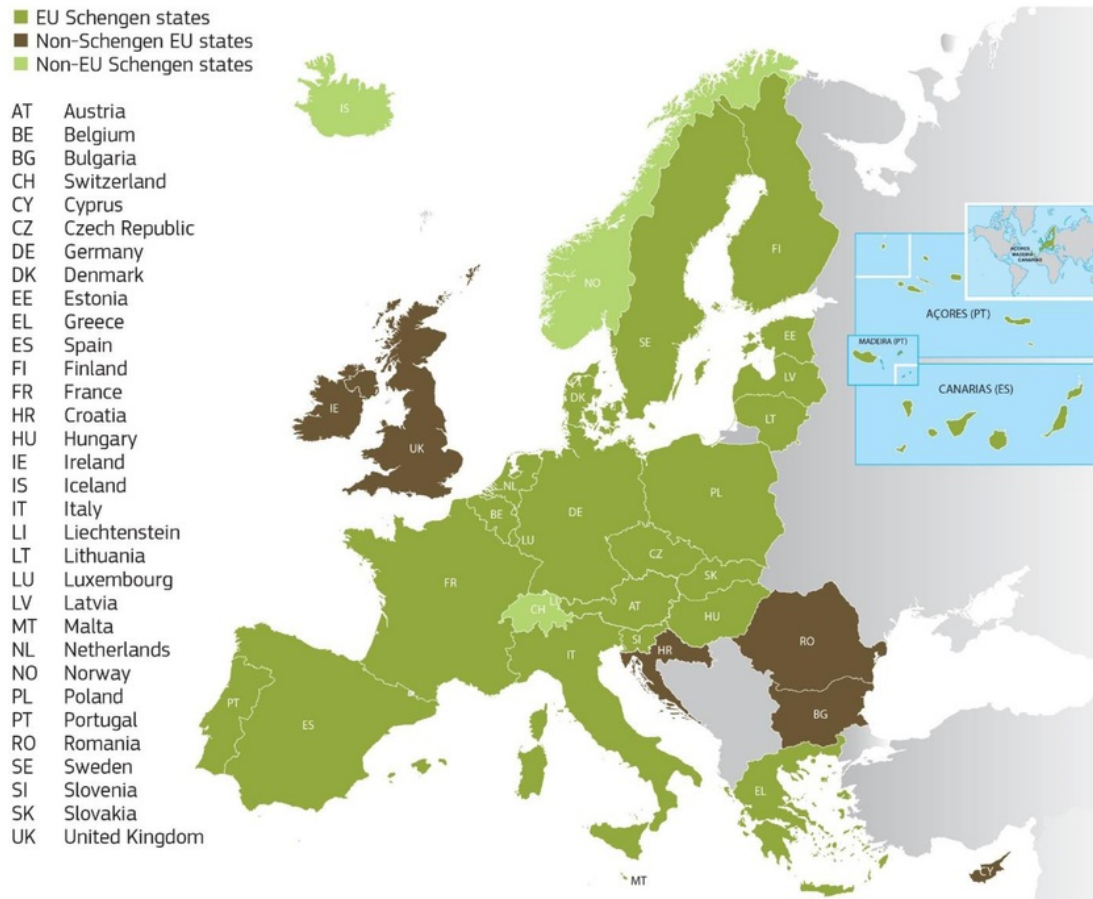
### **1.1. Overview of the Schengen Agreement**

The Schengen Agreement is a treaty which resulted in the creation of Europe's Schengen Area, in which internal border checks have mostly been abolished (Peers et al., 2012). In 1985 at the city of Schengen, five of the European Union (EU) countries agreed to facilitate travel within their alliance by removing border crossing points (BCPs) (EC, 2014). This allowed vehicles to cross borders without stopping, residents in border areas to cross away from fixed checkpoints and the harmonisation of visa policies in Belgium, Germany, France, Luxembourg and the Netherlands. Furthermore, it has also highly supported the achievement of the EU's 'four freedoms' which are freedoms of movement of goods, people, services and capital over borders (Dziurdz and Marchgraber, 2015). The abolition of physical stoppages at internal frontiers is indispensable in order to entirely exploit the opportunities afforded by the Internal Market (EPC, 1996). The disappearance of long queues at the BCPs boosted intra-European trade and lowered transportation costs drastically (ERPS, 2016a). Each year, there are 57 million crossings due to the transport of goods by road with a value of €2.8 trillion each year (ERPS, 2016b). Due to Schengen, the costs of trade are decreased by 0.42% to 1.59%, depending on trade partners, geography and other factors (ERPS, 2016b).

Currently, Schengen consists of 26 countries – 22 EU members and four Non-EU, covering an area of 4,312,099 square kilometres and a population of over 400 million people (see Figure 1.1.) (EC, 2014). From the 28 EU Member States (MS) only six are outside of the Schengen zone for different reasons and with various statuses. These six nations are Bulgaria, Croatia, Cyprus, and Romania – legally obliged to join the area, while the UK and Ireland maintain opt-outs (BBC, 2014). These EU countries maintain controls on their interior borders, concurrently they have to progress through border controls in order to enter the Schengen territory (Vermeulen and Desmet, 2017). Since Schengen operates similarly to a single state model, external border controls apply for travellers entering and exiting the area, with no internal border controls. The external borders are controlled by the national authorities of border countries in the interest of other states based on common rules and the same kind of control on entry or exit from the Schengen Area (Vermeulen and Desmet, 2017). The external borders occur between

green coloured countries and non-green coloured countries illustrated on Figure 1.1. (i.e. Hungary – Romania, France – UK, etc.).

Figure. 1.1. Countries in the Schengen Agreement (Adapted from EC, 2014, p2)



Border controls between EU countries was not a vastly discussed topic within the EU, as the Schengen Agreement has been in operation for more than two decades. However, the 2015 migration crisis has demonstrated some vulnerabilities at both external and internal borders of Schengen by which border controls has become at the forefront of EU's agenda (ERPS, 2016c). Subsequently, the uncontrolled secondary movement of migrants led seven EU Member States (MS), Belgium, Germany, Austria, Hungary, Slovenia and Sweden to reinstate border controls on a temporary basis (ERPS, 2016c).

In 2016, as a result of terrorist attacks, France has also reinstated his border controls temporarily (ERPS, 2016c). Furthermore, there has been discussions that border controls may be occurring between Northern-Ireland and Ireland, because of the UK's departure from the EU (McSorle, 2017). These facts are considered sufficient motives to create a multi-method study, which attempts to deepen the understanding of border controls and provide additional awareness of this field. Ultimately this could ameliorate freight transport across borders and bolster logistics and supply chain operations from Romania to Schengen and Schengen to Romania.

## **1.2. Overview of the chosen BCP**

The B-A BCP which joins Romania to Hungary is analysed in this paper.

This BCP is located in the Western part of Romania and the Eastern part of Hungary. It is considered one of the most agglomerated BCP's of the region, as for outbound traffic (RO-HU) lorries are almost served continuously on three lanes (RBP, 2018). Predominantly, at most of the BCPs in Romania, one or two lanes facilitate freight traffic flows.

Ultimately, it is critical to mention that Romania is an EU Non-Schengen country (Figure 1.1). Whereas Hungary is an EU Schengen country and additionally fulfils the role of being an external border of the Schengen Area (Figure 1.1.).

## **1.3. Aims and summary of the chapters**

This paper intended to investigate WTs for freight traffic at the Bors (RO) – Artand (HU) BCP. Alongside, the current state of border management operations at this BCP is evaluated. In order to achieve this aim, this paper has been divided into the following chapters:

Chapter 2 – Review of Literature – This chapter lays down the theoretical background of the present study. It identifies and critically evaluates previous empirical studies concerned with BCPs and WTs. In turn, this allows to identify the gap in the current understanding and formulate the research questions.

Chapter 3 – Research Methodology - Discusses research philosophy and the data collection methods which were identified adequate to carry out the study.

Chapter 4 - Analysis and Results – Presents the analysis and discussion of the primary data obtained through the survey and the questionnaires.

Chapter 5 – This chapter summarises and further discusses the findings and implications, additionally refers to all previous sections, especially the literature review. Moreover, considers a few limitations of the study along with some recommendations for future research.

## **Chapter 2. Literature Review**

### **2.1. Introduction**

Cross-border transportation is an unavoidable factor in global supply chain (SC) management (Sardar and Lee, 2015). Today, numerous countries are involved in the product assembly processes at different stages. This results in increasingly fragmented global SC and multiple border-crossing of components before the final products are assembled. (Nicita et al., 2013). Amongst the global logistics activities, delays at border crossing points represent the main bottleneck <sup>1</sup> to the smooth movement of goods (Coyle et al., 2014). Specifically, long delays at BCPs are considered as the single largest contributor towards the slow speed of freight movement (Hoffman et al., 2013). For instance, the automotive industry spends approximately US\$ 6 billion per year on inventory carrying costs at borders (Francois, 2003). Moreover, border crossing within India from one state to another is a regulatory event, adding 15-20% to the total costs and consuming up to 15% of all transport time. Thus, the effective and efficient border procedures can deliver more benefits to international trade than the reduction of tariffs barriers (Forum, 2014).

Unpredictable times at BCPs increase the SC costs and disruption risk. Furthermore, it is evident that amongst the biggest challenges that trading countries face are border processes, specifically, import and export clearance (Low, 2013). Banomyong (2010) highlights that in Greater Mekong Subregion (Cambodia, China, Laos, Myanmar, Thailand, and Vietnam ) almost half of the total transit time is spent at customs and 43% of the transport costs are collected at BCPs.

In contemporary SC practices, the quantitative and practical understanding of border crossing complexity is the least researched area due to the subjective nature of the field (Sardar and Lee, 2015). Goodchild et al. (2008) observed the border crossing times and how the variability of these impact on regional SCs. They found that late arrivals of goods

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<sup>1</sup> A bottleneck (or a constraint) in a supply chain signifies a resource that necessitates the longest time in operations for certain demand and limits throughput or capacity. (Myerson, 2016)

can result in significant costs to factories and for carriers who miss delivery schedules. The issue of disregarding border crossing bottlenecks can generate unfavourable consequences regarding SC bottlenecks such as strategic failure of the businesses or loss of competitiveness. Bragg (2011) also highlights that recognising constraints or bottlenecks and making improvements will increase the efficiency of the SC, inventory and cash flow throughput or capacity (Myerson, 2016). In order, to maximise the SC benefit, variations must be reduced, and the weakest links in the SC must be uncovered. According to Min (2015), one of the most effective ways of doing so is to apply the theory of constraints (TOC). Therefore, the next sections of the literature review aim to provide a greater understanding of the impact of waiting times (WTs) generated at BCPs, applying the TOC and Lean methodologies. Furthermore, the value of time for freight transport and different studies are critically evaluated, observing WTs between different BCPs from non-Schengen and Schengen countries. Expectantly, these findings will serve as sufficient evidence to accurately establish a research methodology for investigating the Bors (Romanian EU Non-Schengen) – Artand (Hungarian EU Schengen) BCP and draw conclusions on the efficiency of freight transportation.

## **2.2. Theory of Constraints (TOC)**

The TOC, developed by Eliyahu Goldratt, is a methodology of increasing throughput by managing bottlenecks (constraints) (Goldratt, 2010). The main concept of TOC is that every system has at least one constraint that limits the system to produce the maximum of whatever strives to produce and consequently determines the output of the system (Noreen et al., 1995). The TOC adopts the common idiom that “a chain is no stronger than its weakest link” (Shen et al., 2015, p.791) by sustaining that 1% of all events cause 99% of the results.

The TOC analogy can apply to SC, where a weak link can limit the effectiveness and the efficiency of the SC. For example, unpredictable WTs and delays at BCP's can cause delivery delays and increased lead times downstream in the SC, which can impact manufacturers, distributors and can result in product shortages for retailers. Furthermore, customer demands cannot be met, which consequently would deteriorate customer

services. Therefore, the TOC sets out five steps that supply chain partners may consider in order to optimise SC processes (Dettmer, 2000).

1. **Identify** - Discovering the constraint (weakest link)
2. **Exploit** - Deciding about the action to be taken in order to get the most out of the constraint without carrying out potentially expensive changes.
3. **Subordinate** - Adjusting the rest of the SC to a setting which enables the constraint to function at maximum effectiveness.
4. **Elevate** – If the constraint still exists, further actions must be considered to eliminate it from being a constraint.
5. **Repeat** - Once the constraint is resolved, the next constraint must be identified to continuously improve processes.

According to Coyle et al. (2014) in the case of BCPs, the main bottleneck is unpredictable WT<sub>s</sub>. Therefore, the first step of the TOC is accomplished by identifying the bottleneck. The next two steps aim to focus and exploit the constraint by achieving maximum effectiveness.

For example, Romanian Border Police (RBP) in Romania provide on their website live information about WT<sub>s</sub> at BCPs, separately for passenger cars and trucks (Police, 2017). Certainly, this is a step towards the improvement of border crossing processes provided by the RBP. However, this might not deliver the maximum efficiency. Therefore, an option which provides forecasted future crossing times based on the times registered in the past might make border crossing more predictable, eliminating the bottleneck of random WT<sub>s</sub>. In addition, this may help travellers and freight transporters to adjust their operations to WT<sub>s</sub> and take advantage of the less busy periods. Then, information may be exploited, leading to less WT<sub>s</sub> and a leaner transport. Similarly, the RBP can also plan for an expected rise in travellers, freight transporters in specific periods. However, it is unclear to what extent the live traffic information provided by the RBP, improves this bottleneck. Therefore, a study on the awareness of this feature and the frequency of accessing the website by drivers may provide further clarity.

From the present purposes of the dissertation, the steps of the TOC offer techniques towards improvement and approaches to support recommendations.

In the next section, Lean methodologies are analysed with an aim of providing a different view about the adverse impacts of WTs at BCPs.

### **2.3. Lean association with BCPs**

Although “Lean” concepts are deep-rooted in the Toyota Productions System, they can be adapted to support the aims of the dissertation which includes investigating the impact of WTs. Lean in its genuine form is about increasing the speed and flow by eliminating waste from processes (Goldsby and Martichenko, 2005). These are activities that consume resources, but generate no value in the customers’ eyes, and therefore must be removed in the lean paradigm (Womack and Jones, 1996, Bajgoric, 2009). One these wastes is time on hand (waiting) along with overproduction, transportation, stock on hand (inventory) movement, processing itself and making defective products (Ohno, 1988). From all the resources found in logistics and life, perhaps none is more vital than time. It is the only resource can never be reclaimed (Goldsby and Martichenko, 2005).

With regard to cross-border movement of goods, not only transportation is a substantial cost to consider but the time that goods spend in transit including at BCPs. Therefore, transit represents a large part of order lead time, which is a major contributor of order cycle (OC) time. Each step within an OC necessitates a certain amount time to be completed. Similarly, each step can experience variance around the normal time allotment. However, when a step in the order cycle takes longer to complete a task than normally, then the waste of time requires investigation. Consequently, waste leads to poor performance of the step and will negatively impact the next steps in the OC (Goldsby and Martichenko, 2005). Although each of these types of WTs is highly important, in the present research the focus is exclusively on border crossing times and the factors that impact this. Correspondingly, increased, and unpredictable times spent at BCPs are considered as wastes that impacts entire SC and economies. In other words, WTs affects the mobility, delaying the provision of services and the delivery of goods simultaneously. Businesses can face a rise in personnel costs and other indirect costs such as replenishment of their stocks since just-in-time delivery becomes limited (ERPS, 2016a).

A case study by France Stratégie (2016) provides a detailed evaluation of the time delay costs to freight transport in the case of half an hour delay when temporary borders in

France were in operation. They claim that half an hour WTs at BCPs adds an extra 56 million euros for the carrier costs both imports and exports, and an additional six million is associated with the volume of goods. In sum, the total costs were estimated at 62 million euros a year.

#### **2.4. Value of time for freight transport**

In the preceding sections the aim was on presenting how the TOC and “lean” as a concept can be applied to investigating times at BCPs. This section takes this further and focuses on the value of time for freight transport and how much delays cost in terms of monetary costs.

As the studies by France Stratégie (2016) and the European Parliamentary Research Service (EPRS) (2016) stressed, waiting leads to costs for transport users. The value of time (VOT) for freight transport can be based on more objective aspects, including the depreciation of the vehicle, wage of the driver, insurance costs, fuels costs, nature of the cargo (e.g. refrigerated or perishable goods) and further costs for recipients of the goods (e.g. in case of stock shortage). The relevant literature provides examples for different regions/countries on which this estimation is based and accepted as an average. Table 2.4.1. provides a summary of these.

Table 2.4.1. Overview of value of time estimates for freight transport from literature

| Source       | VOT              | Applicable                   | Region            |
|--------------|------------------|------------------------------|-------------------|
| Unite (2003) | €43/vehicle/hour | Freight, heavy goods vehicle | EU15 <sup>1</sup> |
|              | €40/vehicle/hour | Freight, light goods vehicle | EU15              |

| Source              | VOT                 | Applicable                              | Region            |
|---------------------|---------------------|-----------------------------------------|-------------------|
| Heatco (2006)       | €2.98/tonne/hour    | Freight                                 | EU25 <sup>1</sup> |
| Significance (2012) | €38/vehicle/hour    | Freight, average                        | NL <sup>2</sup>   |
|                     | €44/vehicle/hour    | Freight, non-container, 15-40T truck NL | NL                |
|                     | €23/vehicle/hour    | Freight, non-container, 2-15T truck     | NL                |
|                     | €59/vehicle/hour    | Freight, container                      | NL                |
| TØI (2010)          | €62/vehicle/hour    | Freight, large truck                    | NO                |
| TML (2012)          | €36.37/vehicle/hour | Freight                                 | BE                |

The above consulted sources (Unite (2003), Heatco (2006), Significance (2012)) reveal similar values overall.

While newer values are higher than valuations provided by prior studies, this can be explained by inflation. On the other hand, wage costs may be the primary drivers for different estimates between countries. According to Comité National Routier (CNR) (2016), the hourly cost of international driving ranges from €8 per hour for a Bulgarian driver to more than €33 per hour for his Belgian colleague. However, the literature in Table 2.4.1, provides no information related to the nationalities of the drivers. Therefore, as the value of time, a €30-€60 vehicle/hour for freight is accepted as a reasonable average.

In sum, the monetary costs of WTs at BCPs is vital to be comprehended in order to analyse the financial impacts accordingly. In the next sections of the literature review, case studies on WTs at BCPs within the European Union (EU) are evaluated in order to shape an accurate view of the present situation occurring within the EU.

## **2.5. Waiting Times within the EU**

As the Schengen Agreement has been in action since 1985, current data on average WTs at BCPs in the EU for freight transport scarcely exist (European Commission (EC), 2014) (ERPS, 2016). One exception is when few EU MS reintroduced temporary internal BCPs within Schengen. Furthermore, the personnel available to perform security checks, the thoroughness of the control procedure and the number of vehicles wanting to cross the border at a certain location may vary considerably at different times of the year or even day. According to the Trade and Transport Facilitation in Southeast Europe Program (TTFSE) the maximum acceptable time in coherence with the EU for clearance of a vehicle between two countries is 40 minutes (Jakubowski et al., 2016, Anovazzi-Jakab, 2008, Robert Z. Lawrence, 2008). Therefore, it seems timely to investigate more in depth the cross-border movement of goods within the EU for freight, specifically considering BCPs from Non-Schengen to Schengen countries. Firstly, because at the Schengen's External Borders are permanent BCPs in operation and secondly because WTs at BCP's as being bottlenecks impact on the overall efficiency of the EU Transport.

Due to the different nature of temporary and permanent BCPs, the next subsections explore temporary BCP's and permanent BCP's within the EU separately.

### **2.5.1. Temporary reintroduction of border controls within the EU**

ERPS (2016) conducted a study at the request of European Parliament's Internal Market and Consumer Protection Committee. This research paper emphasises the critical challenges with the reintroduction of BCPs evaluating the actual economic costs of vehicle searches, ID checks and the delays at Schengen Borders. Therefore, the Schengen Borders Code allows EU MS the possibility of introducing temporary border controls for a limited time in cases there is a potential threat to internal security or public policy (EC, 2018). Furthermore, as a result of migration crisis and terrorist attacks in Europe a number of temporary border controls have been introduced.

ERPS (2016) stated that BCPs within Schengen instantaneously impact the mobility within the single market, delaying the provision of services and the delivery of goods simultaneously. Depending on the intensity of checks, their findings estimate the time lost

for heavy-duty vehicles such as trucks and buses for 30-60 minutes. In the briefing of this document it has been revealed that Austrian-German, French-Spanish, Sweden-Denmark, and Austrian-Hungarian border closings in 2016 resulted in bottlenecks with WTs of 45 minutes to three hours (EP, 2016).

A different paper was produced on the same topic by France Stratégie (2016). This evaluated the reintroduction of temporary BCPs in France. The reason for this is that France has been one of those countries which implemented temporarily border controls mainly because of the November 13, 2016 terror attacks, as a state of emergency. In its scenario assessment, at the Franco-Belgian, Franco-Luxembourger and Franco-Swiss BCPs, 30 to 60 minutes WTs were observed for freight transport (France Stratégie, 2016). In addition, the Transport and Mobility Leuven (2017) presented a case study in which estimates of reinstating ID checks in the whole Schengen area was revealed for transport users. Assuming WTs of 30 minutes for lorries (max. 60 minutes) and 10 minutes for passenger cars (max. 20 minutes) would add up merely to €2.5 billion (max. €5 billion) as costs for transport users.

These recent studies evaluated the impact of temporary BCPs in certain EU countries.. Since the introduction of the Single European market, border crossing is not a major issue. However, in the east of the European continent waiting periods can be relatively longer, according to a few studies (Miltiadio, 2016, Kindler and Matejko, 2009 and Lilico, 2014).

### **2.5.2. Waiting times at permanent BCP's in Europe**

Miltiadiou et al. (2016) analysed several BCPs in South East Europe and measured for their improvement. The report presents the following findings on Road BCPs, summarized in table 2.5.2.

Table 2.5.2. Border Crossing Times (time ranges of average crossing times – for all vehicle categories, excluding buses)

|                       |                                                                                                                                                                                                                                                              |
|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| From 1 to 30 minutes: | Letenye (HU) – Gorican (HR)<br>Roszke (HU) – Horgos (SRB)<br>Artand (HU) – Bors (RO)<br>Kulata (BG) – Promachonas (GR)<br>Batrovci (SRB) – Lipovac (HR)<br>Zahony (HU)<br>Presevo (SRB)<br>Trbusnica (SRB)<br>Zupanja (HR).<br>Gradina (SRB) – Kalotina (BG) |
| From 31 to 60 minutes | Vatin (SRB) – Stamora Moravita (RO)<br>Obrezje (SL) – Bregana (HR)                                                                                                                                                                                           |
| From 61 to 90 minutes | Kristallopigi (EL)                                                                                                                                                                                                                                           |
| Over 91 minutes       | Giurgiu (RO) – Ruse (BG)<br>Calafat (RO) – Vidin (BG)<br>Vama Albita (RO)                                                                                                                                                                                    |

According to Miltiadou et al. (2016) at three BCPs (Stamora Moravita, Vatin and Trbusnica) for commercial vehicles as stated by BCPs Authorities and based on the data provided by drivers of commercial vehicles, WTs were not significantly different (less than or equal to 10%). The total sample of truck drivers' questionnaires reached almost 3,000 which is considered by the authors of the report a solid base to build on in the analysis. This paper provides an assorted study including EU MS, non-EU MS, Schengen and non-Schengen countries. In order to study WTs accordingly, the authors could have made a distinction between crossings from non-Schengen to Schengen Area. Therefore, there are procedural differences between these countries which may be impacting on traffic flows.

### **2.5.3. BCP's between EU MS and non-EU MS**

Kindler and Matejko (2009) measured the average times of border crossings for passenger cars from Non-EU countries into EU MS. The same BCP of Vatin (SRB) – Stamora Moravita (RO) average times compared to the study by Miltiadou et al. (2016) significantly differed. Thus, Kindler and Matejko (2009) measured 13 minutes as an average time to cross, while Miltiadou et al. (2016) from 31 to 61 minutes. However, Miltiadou et al. (2016) included all vehicle categories except buses which may be the reason for longer times, but the same study reported that there is no significant difference between commercial vehicles and non-commercial vehicles. Besides, there is 7 years difference in time between these two studies, which makes it quite inappropriate for comparison and any further conclusions.

Findings by Kindler and Matejko (2009) reveal that the average times at nineteen EU crossings across Non-EU States were 170 minutes. These times are considerably longer compared to the ones registered during the temporary reintroduction of border controls within the EU or any other findings (ERPS, 2016a, EP, 2016). Table 2.5.3 represents the specifics about BCP's and average times. According to the Lawrence et al. (2008) excessive waiting periods have also been observed at Poland-Ukraine, Belarus-Russian Borders. In the process of identifying the problem, a distinction must be made between inbound and outbound traffic flows at these borders. Therefore, it is essential to know if WTs are evenly balanced out, or they more likely occur at entering or exiting points of the EU border. The study emphasises (Kindler and Matejko, 2009) that regardless of whether travellers or freight transporters are EU or non-EU citizens, they are waiting in long queues which is affecting businesses, timely deliveries etc.

Table 2.5.3. Average time to cross at BCP's between EU and non-EU countries (Lilico, 2014)

| EU Country | BCP name          | Non-EU country | Avg. time to cross/ min |
|------------|-------------------|----------------|-------------------------|
| Bulgaria   | Kalotina          | Serbia         | 118                     |
|            | Gjueshevo         | FYROM          | 48                      |
|            | Kapitan Andreevo  | Turkey         | 174                     |
|            | Koindula          | Russia         | 150                     |
| Estonia    | Narva             | Russia         | 107                     |
| Hungary    | Tiszabecs         | Ukraine        | 106                     |
|            | Tompa             | Serbia         | 47                      |
|            | Medyka            | Russia         | 356                     |
|            | Zosin             | Russia         | 287                     |
| Poland     | Terespol          | Belarus        | 315                     |
|            | Goldap            | Ukraine        | 217                     |
|            | Beledy            | Ukraine        | 487                     |
| Romania    | Albita            | Moldova        | 75                      |
|            | Sclueni           | Moldova        | 108                     |
|            | Sighetul Marmatei | Ukraine        | 110                     |
|            | Stamora-Moravita  | Serbia         | 13                      |
| Slovakia   | Velke Slemence    | Ukraine        | 234                     |
|            | Vysne Nemecke     | Ukraine        | 108                     |
| Mean:      |                   |                | 170 minutes             |

#### **Other findings regarding WTs at BCP's**

By the OECD/ECMT (European Conference of Minister of Transport) (2000), an overall objective is set of achieving no more than one-hour WTs and trucks under cover of TIR carnet the target time is less than 10 minutes. Given the context, this may apply for borders with those countries that were not part of the Schengen area in the year of 2000.

HDR Decision Economics (2010) for the California-Mexico border estimated that the average WTs for trucks were around 2 hours. This is in contrast with Felbermayr et al.

(2016) suggesting that based on estimates from the USA's border with Canada and Mexico. The also discuss that the average WTs in the post-Schengen period must not cause delays for more than 20 minutes.

## **2.6. Potential causes for delays at borders**

In 2004, the ECMT prepared a report on the removal of obstacles at border crossings at the request of the Council of Ministers (E.C.M.T, 2005). The main obstacles at road BCPs were as follows: poor infrastructure and facilities, poorly trained border officials, inadequate provision of border crossing procedures and border services.

Kindler and Matejko (2009) similarly collected data at nineteen border crossings prior to the enlargement of the Schengen Area (July – October 2007). The study also emphasises that the main problems were visible in the infrastructure of BCPs, in communication (access to information about BCP procedures) and cooperation between border services. The two studies compared revealed more or less the same reasons for delays. However, no study has explored in depth the impact of each obstacle at a specific border, which further substantiates the need for the present research. The following subsection will explore each obstacle in turn as they will form a vital part of the factors investigated throughout the dissertation.

### **2.6.1. Infrastructure**

The layout and infrastructure are amongst the most vital elements of efficient border crossings (Bigo et al., 2016). Throughout the research, infrastructure was regularly identified as a problematic area and the weakest aspects of the BCP's (Matejko and Kindler, 2009)

According to the Schengen Borders Code, *'Where it is deemed appropriate and if local circumstances so allow, MS should consider installing separate lanes at sea and land border crossing points'* (Peers et al., 2012)p.68.

At several BCP's researched with heavy traffic, the primary problem was that there were no separate lanes for non-EU and EU citizens (Matejko, 2009) . On the Hungarian-Ukrainian Tiszabecs BCP, this was identified mainly as the reason for queuing. Principally, a "one-

lane control" procedure was in place, which meant that vehicles were stopped at one point to allow for customs control (Matejko, 2009).

### **2.6.2. Efficient Co-ordination Border Control Authorities**

Article 9(4) of Schengen Borders code reveals that *'In the event of a temporary imbalance of traffic flows at a particular border crossing point, the rules relating to the use of different lanes may be waived by the competent authorities for the time necessary to eliminate such imbalance.'*(EUR-Lex, 2006)

At the Polish-Ukrainian Medyka border several complaints were registered about the imbalance use of lanes (Matejko, 2009). The EU lane was served faster resulting to shorter queues, whilst in the Non-EU lane the WTs were considerably longer. The Border Guard officers, instead of being flexible, did not allow the non-EU traffic to pass through EU-lane, while that was free (Matejko, 2009). Efficient Co-ordination of border police is necessary for an efficient flow of traffic in order to reduce WTs. One of the aims of this dissertation is to discover potential causes for delays or WTs at B-A BCP. As Matejko (2009) discovered a different issue at each BCP, this further proves that every BCP has its own unique issue which is leading to WTs. Furthermore, surveying hauliers at border can greatly assist in discovering the main cause of delays.

### **2.6.3. Reasons for delays according to truck drivers**

Miltiadou et al. (2016) revealed the typical reasons for delays at BCP's according to approx. 1,500 truck drivers that responded to the relevant questions in a questionnaire.

These are the following:

- The required documentation: 33.4%.
- The custom agents' efficiency (change of shifts, breaks, waiting for other agents to come): 21.9%.
- Lack of necessary infrastructure and equipment: 21.3%.
- Congestion and waiting queues due to high traffic: 17.5%.
- The way the controls and procedures are performed: 3.2%.

- The way of payments at the BCPs and the forwarders services: 1.6%.
- 0.74% of the drivers reported no delays.

## **2.7. Conclusion Literature Review and Research Questions**

Miltiadou et al. (2016) provided some generalised reasons for delays by analysing several BCPs. However, when delays occur at a BCP, generalised data will not serve as sufficient evidence, thus different causes may occur at every BCP. The above-analysed studies were the only ones found concerning with BCPs in Eastern Europe. Neither of these studies made any distinction between EU Schengen and EU Non-Schengen BCPs. Furthermore, as a potential cause of delays at Schengen External BCPs may be that crossing from non-Schengen territory to Schengen, customs procedures are more strict and sophisticated. None of the studies examine these at greater depth. Therefore, the increased flux of migrants and the recent terrorist attacks may have toughened BCPs at Schengen Borders. In order to discover this, it necessitates studying not only a singular BCP but also to investigate separately the inbound and outbound flow of traffic. Apart from identifying the cause of WTs at B-A BCP, a further conclusion can be drawn about traffic flows in Schengen and non-Schengen which can serve with additional information regarding the efficiency of freight transportation in the EU. As soon as the bottlenecks or the root causes of WTs are identified the next steps of the TOC can be followed to maximise the constraint and offer recommendations. Lean methodologies are re-assuring that negative impact of wastes (delays and WTs) on the SC impacts economies and businesses. Furthermore, the case studies on the value of time translate WTs for freight to monetary costs. Then the temporary introduction of BCPs within the EU, serve as a relevant material to compare the experienced WTs to the ones within the Schengen and EU Non-Schengen. However, the findings demonstrate that there is an obvious gap in-depth understanding of the reason for WTs at BCPs which will be aimed to be filled by researching in a mixed-methods design the B-A BCP in the next chapters of the dissertation. In order to address these gaps in the literature, the following RQs are formulated.

R.1. Is there a difference between inbound and outbound waiting times for freight transport at Bors - Artand BCP?

R.2. Is there a difference between waiting times at specific times or days, weeks?

R.3. Is there a difference between waiting times for priority and non-priority loads?

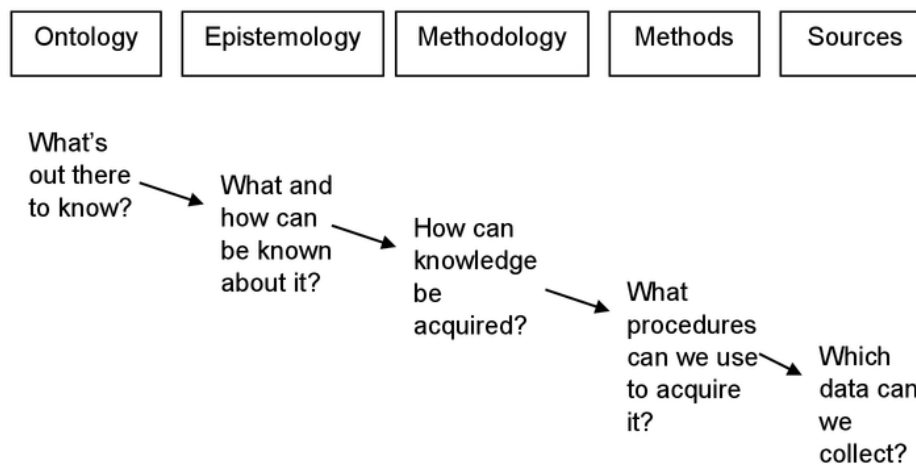
To address these RQs a mixed-method design will be employed and the particulars of this are presented in the next section.

## Chapter 3. Methodology

The Literature Review aimed to provide an overview of past studies associated with WTs at BCPs. Furthermore, observing the adverse impacts and potential causes of WTs was also one of the aims of that chapter.

The Methodology firstly observes research paradigms in order to adequately support the conducted research as well as the methods applied. Saunders et al. (2009) stressed that the adopted research philosophy is paramount importance as it greatly influences the research strategy and the research methodology chosen. In order to provide more clarity to the reader, Figure 3.1. summarizes the steps taken during the planning and analysis stages in this research.

Figure 3.1. Flowchart of steps followed in this section



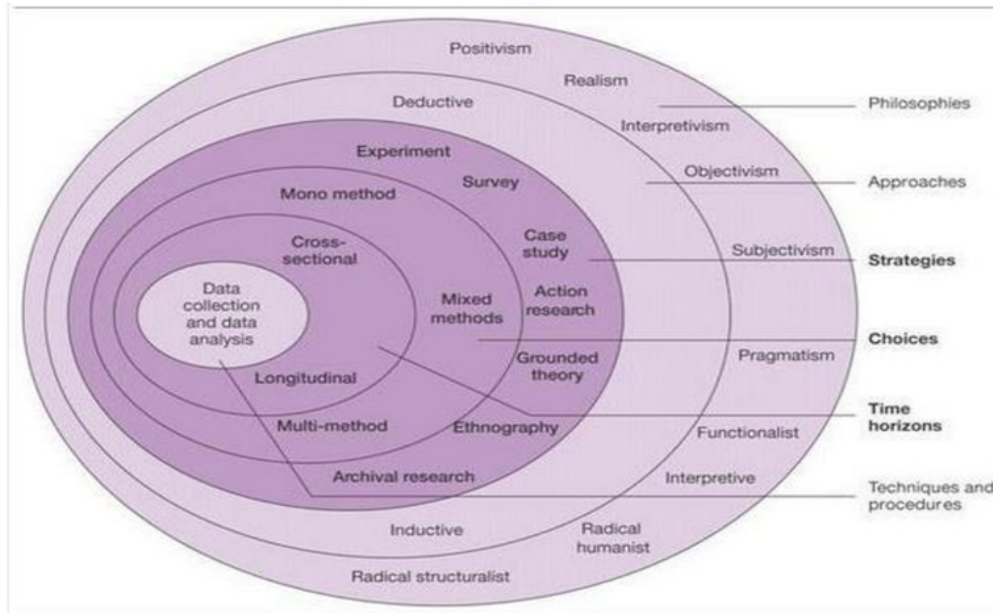
Adapted from Grix, 2002, p. 180

### 3.1. Research Philosophy

According to Guba (1990), research paradigms can be characterised by their epistemology, ontology and methodology. These are going to be discussed in order to create a holistic view of how knowledge is seen and where this present study is positioned in relation to this knowledge. Concurrently, Saunders et al.'s (2007) Research Onion (Figure 2) is utilised to illustrate the different stages that lead to the methods, data

collection and analysis. It begins at the outermost layer with 'approaches', 'strategies', 'choices', 'time horizons' and 'techniques and procedures' at the centre.

Figure 3.2. The Research 'Onion' (Adapted Saunders et al, 2009, p.130)



Ontology is concerned with the nature of the reality and what constitutes acceptable knowledge in a field of study. According to Saunders et al. (2009), there are two main Ontological positions: Objectivism and Subjectivism. The meaning of these positions is explained by Grix (2002, p4):

'Objectivism is an ontological position that asserts that social phenomena and their meanings have an existence that is independent of social actors'.

and

'Subjectivism is an ontological position that asserts that social phenomena and their meanings have an existence that is continually being accomplished by social actors.'

The WT<sub>s</sub> provided by the RBP is considered factual knowledge and trustworthy information which can lead to an observation from an objectivist aspect of the reality. However, this study also has the aim to investigate the reasons of WT<sub>s</sub> at BCPs. Since

relying only on objective border measurements may not provide sufficient understanding of what actually influences these WTs, alternative positions are required. Considering the subject of border crossings, no truth exists and is inviolable. Travelers and freight transporters can experience delays at BCPs caused by various reasons. These can also vary by geographic location of BCPs (EU Schengen, EU non-Schengen), times of the day, week, year and so on. Taking into account truck driver's input frequently crossing the B-A BCP is indispensable in the reality forming process, as these individuals are aware of the occurrences of this BCP. Therefore, as an ontological position subjectivism could be accepted for this research as it allows the validity of personal interpretation of reality.

Epistemology is concerned with the facts that are considered acceptable knowledge and asks questions such as how these should be acquired and interpreted in a field of study. Saunders et al. (2009) state that there are three Epistemological stances: Positivism, Interpretivism and Realism.

Positivism adheres to the view that only 'factual' knowledge gained through observation including measurement is trustworthy (Radovi-Markovi and Alecchi, 2016). Therefore, the role of the researcher in positivism studies is often limited to collection and interpretation of data in an objective way. Moreover, the research findings in these studies are generally observable and quantifiable. The positivist approach may be identified as one of the appropriate views for observing WTs at B-A BCP, but there are various factors that this study considers apart from facts. The Interpretist view, on the other hand, rejects the absolute facts and suggests that facts are based on perceptions rather than on objective truth (Saunders et al., 2009). Realism is located in between these Interpretist and Positivist paradigms (Collins, 2017).

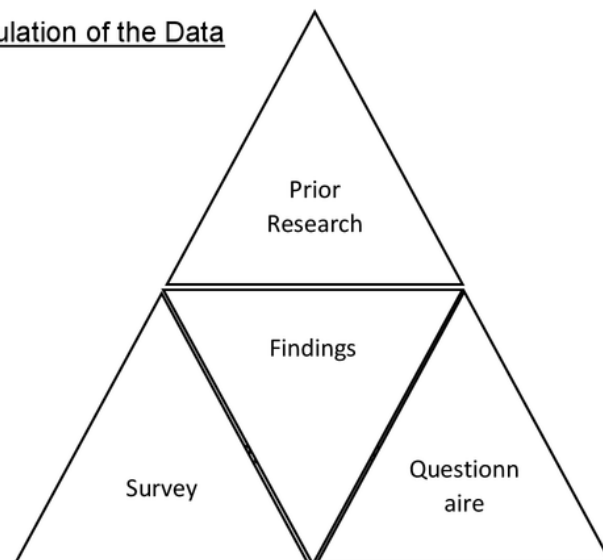
As Positivism and Interpretivism dominated epistemological paradigms, Post-Positivist positions such as Realism also deserves consideration. Creswell (2017) considers post-positivism as an extension of positivism which challenges the traditional notion of the absolute and objective truth of knowledge. Gratton and Jones (2004) state the view of post-positivism that in reality understanding cannot be gained merely through measurement. Post-positivist positions demonstrate a much greater openness to different

methodological methods and can often include quantitative and qualitative methods (Vosloo, 2014) . This permits the development of alternative research strategies to gather information in creative and unlikely ways. Moreover, researchers in this paradigm, believe in multiple viewpoints from participants rather than a single reality (Vosloo, 2014). Denzin and Lincoln (2011) stresses that post-positivism relies on multiple or mixed methods for capturing as much of reality as possible (Schlegel, 2015).

Therefore, the Realist paradigm is adopted for the methodology of this research as through mixed methods different realities are going to be explored, creating a case study based on one border crossing. Consequently, discovering these realities will allow triangulation in order to ensure the validity of the research (Figure 3.3). According to Polit and Beck (2004) data triangulation involves the use of multiple data sources for the purpose of validating conclusions. Figure 3.3. presents an overview of how the findings and implications in the conclusion will be drawn. These will be based on three realities.

The first reality is provided by a survey on WTs at B-A BCP registered in a period of five months. The second reality is shaped by a questionnaire discovering truck driver's input related to WTs and potential causes. Ultimately, the Trade and Transport Facilitation in Southeast Europe (TTFSE) forms the third reality based on prior research, revealing that the maximum acceptable time in accordance with the EU for clearance of a vehicle between two countries is 40 minutes (Jakubowski et al., 2016). Additionally, Miltiadou et al. (2016) reality on the B-A BCP is also considered as part of the evidences. These realities are going to be discovered throughout this study to provide a greater understanding about WTs at B-A BCP.

Figure. 3.3. Triangulation of the Data



### **3.2. Case Study on Artand – Bors BCP**

Yin (2013) highlights that a case study is an empirical investigation within of a contemporary phenomenon within its real-life context using multiple sources of evidence'. He also stated that within a case study the boundaries between the phenomenon and context are not clearly evident. In the B-A BCP's situation, indeed, there is no clear evidence about the occurrence of delays or severity of these. The context RBP only reveals real-time information about lengths of WTs at this specific BCP. This study aimed to exploit this information to identify patterns, times when delays are more likely to occur and recommend for improvements. In order to achieve this goal, a survey and a questionnaire is used as different data collection techniques. Consequently, the evidence gained by these techniques can be triangulated in order to acquire a purer picture of 'what?', 'why?' and 'how?' is occurring at B-A BPC.

#### **3.2.1. Survey**

Surveys are designed to provide a 'snapshot of how things are at a specific time'. There is no attempt to manipulate variables or control conditions (Kelley et al., 2003). According to Kelley et al. (2003) surveys are well suited to descriptive studies and similarly used to explore aspects of situations or to seek explanation and provide data for testing hypotheses.

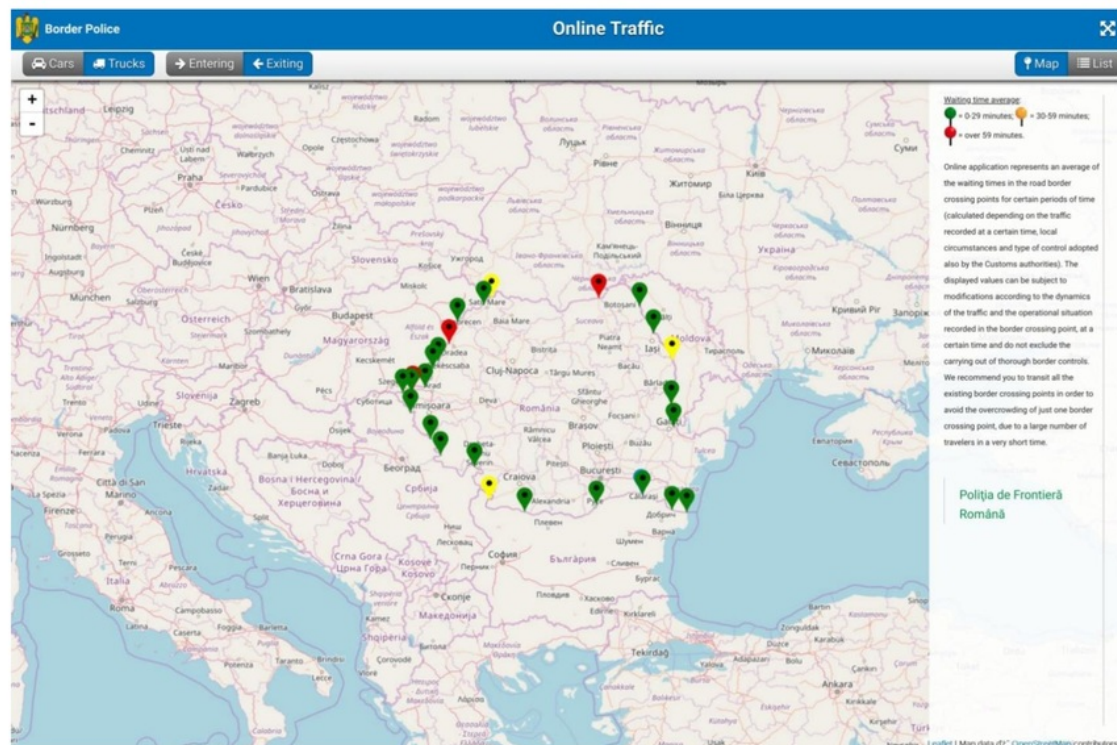
Frequently, surveys and questionnaires are used interchangeably, however, this study intends to make a distinction between these two terms. According to Webster's New World Compact School and Office Dictionary (4th Edition), a questionnaire is 'a written or printed set of questions used in gathering information from people.' A survey is 'a detailed study as by gathering information and analysing it'.

In this current research, the data is collected exclusively on WTs for trucks including inbound and outbound at the B-A BCP. This real-time data is available to the public by accessing the RBP website. Furthermore, the WTs occurring at every single BCP in Romania is revealed here, both for cars and trucks including inbound and outbound. The RBP notes that the times 'represent an average of the waiting times in the road border crossing points' (RBP, 2018). However, the RBP did not clarify whether these average

WTs encompass the whole process of crossing the border from the moment of the arrival at the end of the queue or only refer from the end of the queue to the point when border control officers check for documentation. Therefore, in the absence of this essential information, this study becomes limited to consider WTs on the RBP website, as times which reflect the severity of delays at the moment when they were registered, rather than the exact time of crossing the border for freight.

Additionally, WTs are classified by their lengths within groups, pre-set by the RBP. If the average of WTs is between 0-29 minutes, a green pin appears at the location of the BCP, presented on the Romanian Map (Figure 3.1.1). Similarly, if WTs is between 30-59 minutes an amber pin and over 59 minutes a red pin signifies the length of WTs on the map (RBP, 2018). These time frames are further applied in this study as the key performance indicators of the RBP. By clicking on this pin, the average length of WTs is revealed at that BCP. Figure 3.1.1. provides an overview of the outlook of this website.

Figure. 3.2.1. Online Traffic Screenshot – RBP Website (Adapted RBP, 2018)



The WTs provided on this website have been precisely recorded at different times of the day, night, for a five months period (1<sup>st</sup> November 2017 – 31<sup>st</sup> March 2018). In order to eliminate systematic bias and providing each time with the same likelihood of being chosen, simple random sampling (SRS) have been used. The SRS approach is the best way to ensure that the sample represents the population at large, and that the findings in the sample can be generalised to the population from which the sample was obtained (Moyé, 2007). If each member of the population has the possibility of being chosen for the sample, then no member is excluded a priori at the expense of another. Furthermore, there is no built-in-biases against any subject based on that subject's individual characteristics (Moyé, 2007).

Fifteen hundred random sample times generated in Microsoft Excel represented the times when the RBP's website was accessed to capture the current WTs for trucks inbound and outbound. These times, appeared to be often in unsociable hours, therefore a web application Stillio has been used to capture screenshots previously scheduled by the researcher. Furthermore, the times were captured in UTC +0 (Universal Time Coordinated) which differs from the Romanian EET +2 (Eastern European Time). Therefore, in chapter five during the analysis, the two-hour time difference will be added to the existing times in order to obtain accurate conclusions.

The survey, provided with a reasonably large data set at random times, which will be further analysed to investigate whether any conclusions can be drawn. As this data might be limited in terms of exploring the reasons of WTs a different data collection method is applied, targeting truck drivers.

### **3.3. The Questionnaire**

The questionnaire is a well-established tool within social sciences for acquiring information on participants present and past attitudes or behaviour, characteristics but also beliefs and reasons regarding the topic under investigation (Bird, 2009). In this study, the aims are to gather, analyse and interpret the perception of truck drivers of crossing the B-A BCP. Therefore, the first-hand information that truck drivers possess about the on-goings at that specific BCP can significantly contribute in answering research questions.

The questionnaire is considered as the adequate data collection method due to the following factors:

- Truck drivers can remain anonymous
- Ability to distribute to numerous truck drivers in a short period of time
- Low implementation costs
- Ease of the analysis of the data

On the other hand, few of the disadvantages are also considered:

- Limited choice of answers
- Meaning of questions may be unclear
- Imposition problem: risk that the researcher might be imposing their own framework or views on the people being researched rather than acquiring what exactly the respondents think
- Requires the personal presence of the researcher

The pilot discussed in the next subsection, intends to consider the disadvantages, and mitigate any issues discovered before the live distribution of the questionnaire. In the planning and designing phases of the questionnaire additional key points have been taken into account:

- Firstly, that truck drivers might be having different crossing experiences from Schengen to non-Schengen and vice versa. Therefore, it was found necessary to distribute the questionnaires on each side of the border separately.
- Secondly, drivers idling in the queues were mainly targeted on each side, as they are considered keener to fill out these while they were waiting.
- Thirdly, suspecting that most of the drivers travelling through this BCP are either Hungarian or Romanian (considering the nature of this BCP), the questionnaire was designed in three languages (Hungarian, Romanian, Polish) and additionally in English for other nationalities. If drivers reveal that do not possess the necessary language skills, they will not be asked for completion of the questionnaire.

The questionnaire begins with a short and clear introduction about the researcher, stating the name, university and the intention of this questionnaire. Subsequently, the questionnaire intends to identify those drivers who are travelling the first time through this BCP as these individuals are not considered able to serve with reliable information about past experiences nor WT's. They are kindly asked to not carry on with the completion of the questionnaire.

Then, it is stated that the questions apply on the actual side of the border where the questionnaire is distributed. In due course, ten short closed questions are presented, along with single and multiple-choice answers. A copy of the questionnaire can be found in the Appendix 1 section.

### **3.3.1. The questions**

The first question seeks to discover the travelling frequency of the drivers within the last month. This information then can be used in conjunction with the average WT's times presented in the next question. By having an approximate WT's and a number of crosses, the estimate of the total WT's for that month can be revealed.

The second and third questions look for the average and the longest WT's experienced by the lorry drivers. This information then can be compared with the times captured from the survey. Moreover, this facilitates the triangulation of the data.

The fourth and fifth question investigates if there are days of the week and times of the day when delays are more likely to occur. Similarly, comparing these responses to the times recorded in the survey expectedly exposes specifics about delays.

The sixth question seeks to uncover whether the Hungarian HGV Sunday Restrictions influence WT's at the borders. It is essential to consider that drivers may begin to queue on the Romanian side to continue their journey as soon as the restrictions are lifted.

Question number seven asks for the driver's input about the causes that is considered to generate the longest delays. Despite their subjective opinion, as users of this BCP, they can reveal information about the most time-consuming processes that may result in

delays. The respondents can choose from four causes, previously identified in the literature, including Miltiadou et al.'s (2016) questionnaire.

The eighth question investigates if the respondents transport any of the priority loads. According to RBP (2018), livestock, perishable, refrigerated, explosive, flammable goods and emergency vehicles have priority at all times to cross the border without waiting in a line. The reasoning behind this question is to distinguish these individuals, as their experience might be different from the majority. Furthermore, their input may also serve with some insight about how border crossing operates for priority loads.

Question number nine intends to discover whether the respondents live locally (within 100km). As two large cities, Oradea (RO) and Debrecen (HU) are located within a 100km radius to this BCP, the logistics activities occurring between these two cities is considered as an influential factor which can result to increased traffic at the borders. If a significant percentage of the drivers appears to be local, this is further investigated.

The tenth question asks for the driver's awareness of the WTs presented on the RBP website. As it has been revealed earlier, WTs on every BCP in Romania is presented here real-time. The awareness of the exact WTs might motivate drivers to modify their route and travel through another nearby BCP, if long delays occur.

### **3.3.2. The Pilot Questionnaire**

A pilot or a pre-testing phase was undertaken in order to improve the quality and the efficiency of the questionnaire. The primary focus was to evaluate whether the wording is clear, logical, unambiguous, and understandable for the target population. The completing time was also intended to be known, as queues may not occur at the borders at all times and drivers cannot afford to spend longer periods completing the questionnaire. Furthermore, it was unknown which of the two methods provide the most efficient way for questionnaire distribution; handing over the paper copy to the drivers or reading aloud the questions and answers and capturing the responses.

Therefore, both methods were tested. Six Romanian drivers completed the questionnaires. Two of them have been asked to complete it on their own, which has taken about 3 - 5 minutes. They did not require any support; no further questions have

been asked. On the other hand, when the questions and answers were read aloud, the respondents did not understand it properly due to the nature of being on a busy road with loud noises in the background. Moreover, the duration of presenting the questionnaires through this method taken over 7-8 minutes. It has also been identified that using the hand over method, the presence of the researcher was not required, and several drivers can complete it simultaneously. Consequently, the hand over method is chosen for the main study.

Furthermore, the pilot has provided an insight that numerous Polish drivers cross this BCP. However, their English language skills were not adequate enough to complete the English questionnaire. Therefore, designing a Polish version of the questionnaire was considered highly advantageous in order to extend the target population for the main study. A native polish speaker university colleague has been asked to assist with the translation of the questionnaire in order to ensure validity.

In sum, the pilot was especially useful in terms to notice where improvements can be made and to test the two distribution methods. As the phrasing and the language were understandable for all the respondents, no changes are made to the questionnaire.

### **3.4. Data Collection and Analysis**

Firstly, the survey data was analysed in Microsoft Excel, where the data was originally captured and then exported to GraphPad Prism for further statistical tests. In Microsoft Excel, the primary goal was to improve the transparency, concurrently providing some simple measures and descriptive statistics of the data. Alternatively, in GraphPad Prism statistical tests provided the inferential part of the analysis, where the findings were evaluated based on their statistical significance. As the first step, D'Agostino-Pearson test observed whether the sample derived from a normally distributed population. The results of these tests provide critical conclusions in deciding the type of tests used for the rest of the survey data analysis (Elliott and Woodward, 2014). If the data had not shown significant departure from the normality, a parametric test, independent sample t-test would have been used for comparing means (Hinton et al., 2014). In the case of a significant departure from the normality, a non-parametric statistical test Mann-Whitney U (M-WU) is used. In essence, the M-WU test is the nonparametric version of the

independent samples t-test. The M-WU test is designed for use with unrelated samples and uses the ranks of the sample scores, rather than the score themselves (Weinberg and Abramowitz, 2008).

Next, the questionnaire results were manually coded into Statistical Package for Social Sciences (SPSS). Since the different data collection methods have occurred in this study, different software packages proved to be uniquely effective in the process of analysing the data.

The results acquired from the questionnaire coded into SPSS enabled the comprehensive analysis of the data by undertaking various tests such as Pearson's Chi-Square (non-parametric test) for an association, and Independent Sample t-test (parametric test) for comparing means. Equally, the normality of the only scale variable present in the questionnaire data was also tested in order to decide whether an Independent Sample T-test or an M-WU test is appropriate to use.

In the testing phase of the questionnaire analysis, hypotheses were proposed and used to determine if there is sufficient evidence available in the sample of data to conclude that a certain condition is true for the entire population. The null ( $H_0$ ) and the alternative ( $H_a$ ), two opposing hypotheses were proposed about the population. The null hypothesis ( $H_0$ ) was the statement that being tested. Generally, the null hypothesis was a statement of 'no difference' or no relationship. Consequently, the alternative hypothesis ( $H_a$ ) revealed that there was a statistically significant difference between two variables.  $H_0$  was rejected in the event of  $p > 0.05$  and  $H_a$  was accepted in the case of  $p \leq 0.05$ .

The next chapter aims to examine the acquired data and to extract the necessary evidence in order to answer the research questions accurately. As an exploratory case study, the data will be subjected to further analyses in order to investigate additional findings that may emerge based on the triangulation of the three data sets collected.

## Chapter 4. Analysis and Results

This chapter presents the analysis of the data obtained from the survey, as well as from the questionnaire.

First, the survey data is presented along with some descriptive statistics, followed by the appropriate inferential statistics. The average WTs are examined from different angles such as hours of the day, days of the week, and weeks of the month in order to discover patterns of busy periods at this BCP. Although these WTs cannot be considered as an exact measure that is a true reflection of what happens in reality, however based on the official information revealed by the RBP, it provides an informative insight into the different tendencies that occur.

Secondly, the questionnaire data is analysed, whereas truck driver's perception provides a more subjective perspective, this is considered equally essential to broaden the understanding of this BCP.

### 4.1. Survey data analysis

The survey contains 1512 inbound and 1512 outbound times captured for freight transport at the B-A BCP. The inbound (IB) times represent the times for trucks travelling from Hungary to Romania (HU-RO), while the outbound (OB) times from Romania to Hungary (RO-HU). Throughout this section, the times are displayed in the corresponding tables in minutes and seconds.

Beginning with, Table 4.1.1 few important insights can be observed about the dataset.

Table 4.1.1. Descriptive statistics of IB and OB times

|        | HU - RO | RO -HU |
|--------|---------|--------|
| Median | 20.00   | 30.00  |
| Mode   | 20.00   | 20.00  |
| Mean   | 22.45   | 50.43  |
| SD     | 10.50   | 45.82  |
| Max    | 100.00  | 260.00 |
| Min    | 20.00   | 10.00  |

At first glance, it can be observed that the mean of the IB times and the OB times differ. Crossing times from HU to RO has been measured on average as 22.45 minutes, while the times from RO-HU were 50.43 minutes over a five months period. The mean of these two values (22.45 and 50.43) reveals the average of crossing times at B-A BCP which is 36.44 minutes. However, further in the analysis inbound and outbound times are separately discussed, as these are more representative.

The maximum crossing times (100 min and 260 min) also reflect that there are notable differences between the WTs in transporting freight to Hungary from Romania, compared to WTs from Romania to Hungary.

By looking at the frequencies of minutes registered in the survey, presented in Table 4.1.2 and 4.1.3, the same phenomenon is noticeable.

Table 4.1.2. Frequencies Inbound

| HU - RO |      |     |
|---------|------|-----|
| 20      | 1374 | 91% |
| 40      | 95   | 6%  |
| 60      | 14   | 1%  |
| 80      | 11   | 1%  |
| 100     | 18   | 1%  |

Table 4.1.3. Frequencies Outbound

| RO - HU |     |       |
|---------|-----|-------|
| 20      | 684 | 52,5% |
| 40      | 305 | 23,4% |
| 60      | 160 | 12,3% |
| 80      | 85  | 6,5%  |
| 100     | 70  | 5,4%  |

As Table 4.1.2 presents, travelling inbound crossing times were 20 minutes 1374 times which makes up to 91% of the captured times. On the other hand, outbound times were 20 minutes 684 times (Table 4.1.3) which is half compared to inbound times. Seemingly, longer WTs appear much more frequently outbound than inbound. This critical observation stood out almost in every calculation executed, which will be further noticeable during the analysis of the survey.

In order to reveal whether there is a statistical difference between the IB and OB times, the normality of the data is inspected, applying D'Agostino-Pearson test, presented in Table 4.1.4.

**Table 4.1.4. D'Agostino – Pearson normality test**

| D'Agostino – Pearson test           | IB Minutes | OB Minutes |
|-------------------------------------|------------|------------|
| Number of values                    | 1512       | 1512       |
| Minimum                             | 20         | 10         |
| 25% Percentile                      | 20         | 20         |
| Median                              | 20         | 30         |
| 75% Percentile                      | 20         | 60         |
| Maximum                             | 100        | 260        |
| Mean                                | 22.45      | 50.43      |
| Std. Deviation                      | 10.5       | 45.82      |
| Std. Error of Mean                  | 0.2701     | 1.178      |
| Lower 95% CI of mean                | 21.92      | 48.12      |
| Upper 95% CI of mean                | 22.98      | 52.74      |
| Sum                                 | 33939      | 76245      |
| D'Agostino & Pearson normality test |            |            |
| K2                                  | 1650       | 596.2      |
| P value                             | <0.0001    | <0.0001    |
| Passed normality test (alpha=0.05)? | No         | No         |

D'Agostino – Pearson normality test indicates that IB and OB minutes significantly differ from a normal distribution  $p < 0.0001$ . Therefore, an M-WU test is applied to further investigate whether there is a statistically significant difference between these two variables.

**Table. 4.1.5. M-WU test – IB vs OB**

| Man-Whitney Test                    | IB vs OB         |
|-------------------------------------|------------------|
| P value                             | <0.0001          |
| Exact or approximate P value?       | Approximate      |
| P value summary                     | ****             |
| Significantly different (P < 0.05)? | Yes              |
| One- or two-tailed P value?         | Two-tailed       |
| Sum of ranks in column C, D         | 1753555, 2820245 |

|                            |            |
|----------------------------|------------|
| Mann-Whitney U             | 609727     |
| Difference between medians |            |
| Median of column C         | 20, n=1512 |
| Median of column D         | 30, n=1512 |
| Difference: Actual         | 10         |
| Difference: Hodges-Lehmann | 10         |
| Difference: Actual         | 609727     |

The test indicated that WTs for outbound ( $Mdn = 30$ ) was greater than for inbound ( $Mdn = 20$ ,  $U = 609727$ ,  $p < 0.0001$ ). Consequently, there is a very high statistical difference between outbound and inbound sides, as it is reported in Table 4.1.5.

Since this information is valuable but does not provide any detailed insight of when WTs occur, a wider view is taken at the data. Therefore, progressively examining times distinguished in hours of the days, days of the week, weeks of the months is considered an essential part of the analysis of the survey data.

#### 4.1.1. WTs from the hours of the day and days of the week perspective

Table 4.1.6. Summaries of hours of the day

|        | 0:00 - 6:00 |         | 6:01 - 12:00 |         | 12:01 - 18:00 |         | 18:01 - 23:59 |         |
|--------|-------------|---------|--------------|---------|---------------|---------|---------------|---------|
|        | HU - RO     | RO - HU | HU - RO      | RO - HU | HU - RO       | RO - HU | HU - RO       | RO - HU |
| Median | 20          | 20      | 20           | 30      | 20            | 40      | 20            | 40      |
| Mode   | 20          | 20      | 20           | 20      | 20            | 20      | 20            | 20      |
| Mean   | 21          | 33      | 22           | 46      | 23.2          | 60.8    | 24.0          | 60.4    |
| SD     | 4           | 28      | 8            | 43      | 12.0          | 54.4    | 14.3          | 46.8    |
| Min    | 20          | 10      | 20           | 10      | 20            | 10      | 20            | 10      |

Table 4.1.6 illustrates that based on the means the busiest times of the day are between 12:01–18:00 and 18:01–23:59 at B-A BCP.

The WTs were measured here the highest in an average of 24.00 minutes for inbound between 18:01–23:59 and 60.4 minutes for outbound between 18:01–23:59, in the five months period. However, it may be noted that between the means of the two most

agglomerated time-frames, there is less than half minute difference both inbound and outbound. Therefore, the execution of further statistical tests is considered necessary in order to acquire more clarity on whether there are statistical differences between these times frames.

First, the IB times frames of the day are evaluated and tested against each other in Table 4.1.7, applying M-WU test.

**Table 4.1.7. M-WU test on IB Times.**

| Man-Whitney Test IB Times           | 0:00 - 6:00 vs 6:01 - 12:00   | 0:00 - 6:00 vs 12:01 - 18:00  | 0:00 - 6:00 vs 18:01 - 23:59   |
|-------------------------------------|-------------------------------|-------------------------------|--------------------------------|
| P value                             | 0.7683                        | 0.0061                        | 0.0005                         |
| Exact or approximate P value?       | Approximate                   | Approximate                   | Approximate                    |
| P value summary                     | ns                            | **                            | ***                            |
| Significantly different (P < 0.05)? | No                            | Yes                           | Yes                            |
| One- or two-tailed P value?         | Two-tailed                    | Two-tailed                    | Two-tailed                     |
| Sum of ranks in column C,D          | 128780 , 144651               | 122770 , 139681               | 125456 , 154671                |
| Mann-Whitney U                      | 67705                         | 61695                         | 64381                          |
| Difference between medians          |                               |                               |                                |
| Median of column E                  | 20, n=349                     | 20, n=349                     | 20, n=349                      |
| Median of column I                  | 20, n=390                     | 20, n=375                     | 20, n=399                      |
| Difference: Actual                  | 0                             | 0                             | 0                              |
| Difference: Hodges-Lehmann          | 0                             | 0                             | 0                              |
| Man-Whitney Test                    | 6:01 - 12:00 vs 12:01 - 18:00 | 6:01 - 12:00 vs 18:00 - 23:59 | 12:01 - 18:00 vs 18:01 - 23:59 |
| P value                             | 0.0117                        | 0.001                         | 0.4518                         |
| Exact or approximate P value?       | Approximate                   | Approximate                   | Approximate                    |
| P value summary                     | *                             | ***                           | ns                             |
| Significantly different (P < 0.05)? | Yes                           | Yes                           | No                             |
| One- or two-tailed P value?         | Two-tailed                    | Two-tailed                    | Two-tailed                     |
| Sum of ranks in column C,D          | 145618 , 147378               | 148638 , 163017               | 143986 , 155940                |
| Mann-Whitney U                      | 69373                         | 72393                         | 73486                          |
| Difference between medians          |                               |                               |                                |
| Median of column E                  | 20, n=390                     | 20, n=390                     | 20, n=375                      |
| Median of column I                  | 20, n=375                     | 20, n=399                     | 20, n=399                      |
| Difference: Actual                  | 0                             | 0                             | 0                              |
| Difference: Hodges-Lehmann          | 0                             | 0                             | 0                              |

Table 4.1.7 presents that testing 0:00-6:00 vs 6:01-12:00 and 12:01-18:00 vs 18:01-23:59, demonstrating no significant differences. The mean times are the highest for 12:01-18:00 and 18:01-23:59 which do not meaningfully differ from each other but differ from the rest of the times frames. Furthermore, 0:00-6:00 vs 6:01-12:00 with the lowest mean times differs from the rest, but not from each other. Despite the small differences

in the mean values, the M-WU tests confirm that there is a variation even within the IB times of the day.

**Table 4.1.8. M-WU test on OB Times**

| Man-Whitney Test OB Times           | 0:00 - 6:00 vs 6:01 - 12:00   | 0:00 - 6:00 vs 12:01 - 18:00  | 0:00 - 6:00 vs 18:01 - 23:59   |
|-------------------------------------|-------------------------------|-------------------------------|--------------------------------|
| P value                             | <0.0001                       | <0.0001                       | <0.0001                        |
| Exact or approximate P value?       | Approximate                   | Approximate                   | Approximate                    |
| P value summary                     | ****                          | ****                          | ****                           |
| Significantly different (P < 0.05)? | Yes                           | Yes                           | Yes                            |
| One- or two-tailed P value?         | Two-tailed                    | Two-tailed                    | Two-tailed                     |
| Sum of ranks in column C,D          | 117721 , 155709               | 104989 , 157462               | 102195 , 177931                |
| Mann-Whitney U                      | 56646                         | 43914                         | 41120                          |
| Difference between medians          |                               |                               |                                |
| Median of column E                  | 20, n=349                     | 20, n=349                     | 20, n=349                      |
| Median of column I                  | 30, n=390                     | 40, n=375                     | 40, n=399                      |
| Difference: Actual                  | 10                            | 20                            | 20                             |
| Difference: Hodges-Lehmann          | 0                             | 10                            | 20                             |
| Man-Whitney Test                    | 6:01 - 12:00 vs 12:01 - 18:00 | 6:01 - 12:00 vs 18:00 - 23:59 | 12:01 - 18:00 vs 18:01 - 23:59 |
| P value                             | <0.0001                       | <0.0001                       | 0.1717                         |
| Exact or approximate P value?       | Approximate                   | Approximate                   | Approximate                    |
| P value summary                     | ****                          | ****                          | ns                             |
| Significantly different (P < 0.05)? | Yes                           | Yes                           | No                             |
| One- or two-tailed P value?         | Two-tailed                    | Two-tailed                    | Two-tailed                     |
| Sum of ranks in column C,D          | 137056 , 155939               | 135693 , 175963               | 141154 , 158772                |
| Mann-Whitney U                      | 60811                         | 59448                         | 70654                          |
| Difference between medians          |                               |                               |                                |
| Median of column E                  | 30, n=390                     | 30, n=390                     | 40, n=375                      |
| Median of column I                  | 40, n=375                     | 40, n=399                     | 40, n=399                      |
| Difference: Actual                  | 10                            | 10                            | 0                              |
| Difference: Hodges-Lehmann          | 0                             | 10                            | 0                              |

Table 4.1.8 reveals that there are also statistical differences between the OB times of the day, with one exception 12:01-18:00 vs 18:01-23:59. As the mean value for these two-time frames was measured 60.0 and 60.4 minutes, the M-WU test confirms that there is no statistical difference. However, the rest of the time frames significantly highly differ from these time frames. Therefore, it can be concluded that the busiest time frames of the day are 12:01-18:00 and 18:01-23:59, with no significant differences observed between.

In order to further broaden understanding, these four-time frames are studied from the day of the week perspective. The entire data can be found in the Appendix 2 section.

IB and OB WTs are separately discussed in the next subsection in order to provide a more accurate analysis of the sides.

#### 4.1.1.1. Outbound WTs from the hours of the day and days of the week perspective

Table 4.1.9. Busiest Outbound WTs

|        | Tuesday       |               | Wednesday     |               |
|--------|---------------|---------------|---------------|---------------|
|        | 12:01 - 18:00 | 18:01 - 23:59 | 12:01 - 18:00 | 18:01 - 23:59 |
|        | RO -HU        | RO -HU        | RO -HU        | RO -HU        |
| Median | 80.00         | 80.00         | 100.00        | 70.00         |
| Mode   | 20.00         | 110.00        | 100.00        | 20.00         |
| Mean   | 88.89         | 89.10         | 93.51         | 85.66         |
| SD     | 64.24         | 47.06         | 53.12         | 58.45         |
| Max    | 250.00        | 200.00        | 250.00        | 250.00        |
| Min    | 20.00         | 20.00         | 20.00         | 20.00         |

Based on the mean times, extracted from the times of days week table presented in Appendix 2 section, Tuesday and Wednesday, 12:01-18:00 and 18:01-23:59 appear to be the one with the longest WTs registered. However, the M-WU tests aim to discover how much these days and times differ from each other. Table 4.1.10 reveals this information.

**Table 4.1.10. Statistical Test on OB Busiest Hours Times**

| Man-Whitney Test Busy OB Times      | TUE 12:01 - 18:00 vs TUE 18:01 - 23:59 | TUE 12:01 - 18:00 vs WED 12:01 - 18:00 | TUE 12:01 - 18:00 vs WED 18:01 - 23:59 |
|-------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|
| P value                             | 0.3998                                 | 0.3016                                 | 0.953                                  |
| Exact or approximate P value?       | Exact                                  | Exact                                  | Exact                                  |
| P value summary                     | ns                                     | ns                                     | ns                                     |
| Significantly different (P < 0.05)? | No                                     | No                                     | No                                     |
| One- or two-tailed P value?         | Two-tailed                             | Two-tailed                             | Two-tailed                             |
| Sum of ranks in column C,D          | 3946 , 4569                            | 3616 , 3645                            | 3950 , 3801                            |
| Mann-Whitney U                      | 1930                                   | 1600                                   | 1910                                   |
| Difference between medians          |                                        |                                        |                                        |
| Median of column E                  | 80, n=63                               | 80, n=63                               | 80, n=63                               |
| Median of column I                  | 80, n=67                               | 100, n=57                              | 70, n=61                               |
| Difference: Actual                  | 0                                      | 20                                     | -10                                    |
| Difference: Hodges-Lehmann          | 10                                     | 10                                     | 0                                      |
| Man-Whitney Test                    | TUE 18:01 - 23:59 vs WED 12:01 - 18:00 | TUE 18:01 - 23:59 vs WED 18:01 - 23:59 | WED 12:01 - 18:00 vs WED 18:01 - 23:59 |
| P value                             | 0.6742                                 | 0.3513                                 | 0.3267                                 |
| Exact or approximate P value?       | Exact                                  | Exact                                  | Exact                                  |
| P value summary                     | ns                                     | ns                                     | ns                                     |
| Significantly different (P < 0.05)? | No                                     | No                                     | No                                     |
| One- or two-tailed P value?         | Two-tailed                             | Two-tailed                             | Two-tailed                             |
| Sum of ranks in column C,D          | 4104 , 3647                            | 4517 , 3740                            | 3573 , 3448                            |
| Mann-Whitney U                      | 1826                                   | 1849                                   | 1557                                   |
| Difference between medians          |                                        |                                        |                                        |
| Median of column E                  | 80, n=67                               | 80, n=67                               | 100, n=57                              |
| Median of column I                  | 100, n=57                              | 70, n=61                               | 70, n=61                               |
| Difference: Actual                  | 20                                     | -10                                    | -30                                    |
| Difference: Hodges-Lehmann          | 0                                      | -10                                    | -5                                     |

Table 4.1.10 presents that there has been no statistical significance between the OB times registered with the highest average WTs, suggesting that times were similarly agglomerated with no real difference between them. Therefore, the 5<sup>th</sup> busiest time frame (Thursday 12:01-18:00) of 80 minutes based on the means have been compared to Wednesday 18:01-23:59 which resulted in statistical significance between the two variables (Table 4.1.11). On Friday, the longest average WTs were only 42.2 minutes between 12:01 -18:00, which is less than half as long compared to the busiest days and time periods (Appendix 2). This time frame resulted in statistical significance after testing against the four longest mean times. Consequently, these time frames (Table 4.1.10) are seemingly the busiest time frames of the week. A precise analysis would include the testing of 28-time frames (7 days \* 4 times frames per day), however this would require a great amount of time and resource.

**Table 4.1.11. M-WU Test on Thursday 12:01-18:00 vs Wednesday 18:01-23:59**

| Man-Whitney Test OB Times           | THU 12:01 -18:00 vs WED 18:01 - 23:59 |
|-------------------------------------|---------------------------------------|
| P value                             | <0.0001                               |
| Exact or approximate P value?       | Approximate                           |
| P value summary                     | ****                                  |
| Significantly different (P < 0.05)? | Yes                                   |
| One- or two-tailed P value?         | Two-tailed                            |
| Sum of ranks in column C,D          | 117721 , 155709                       |
| Mann-Whitney U                      | 56646                                 |
| Difference between medians          |                                       |
| Median of column E                  | 20, n=349                             |
| Median of column I                  | 30, n=390                             |
| Difference: Actual                  | 10                                    |
| Difference: Hodges-Lehmann          | 0                                     |

In the weekend, outbound average WTs did not even reach 25 minutes within any time-frame, with one exception which was on Sunday from 18:01 – 23:59 (Appendix 2). However, in this period the average WTs not only increased but then doubled. The reason for this is that the drivers on the Romanian side may begin queuing before the Hungarian HGV Restrictions are lifted.

#### 4.1.1.2. HGV Restrictions Impact on Outbound Traffic

The Hungarian HGV Restrictions are from Saturday 22:00 – 24:00 Central European Time +1 (CET) and Sunday 0:00 – 24:00 (CET). Since Romania is part of the Eastern European (EET) time zone, this means that at 01:00 EET Monday, drivers are allowed to continue their journey in Hungary (IRU, 2018).

**Table 4.1.12. Outbound WTs on Sunday (Hungarian HGV Restrictions Impact)**

| RO -HU | 17:00 - 17:59 | 18:00 - 18:59 | 19:00 - 19:59 | 20:00 - 20:59 | 21:00 - 21:59 | 22:00 - 22:59 | 23:00 - 23:59 | 0:00 - 0:59 |
|--------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|-------------|
| Median | 20            | 20            | 40            | 50            | 70            | 70            | 20            | 60          |
| Mode   | 20            | 20            | 30            | 20            | 70            | 70            | 20            | 20          |
| Mean   | 32            | 28            | 45.0          | 46.4          | 71.5          | 81.3          | 35.0          | 84.4        |
| SD     | 18            | 12            | 25.1          | 23.4          | 29.1          | 51.4          | 28.4          | 68.9        |
| Max    | 70            | 50            | 100           | 80            | 110           | 180           | 110           | 180         |
| Min    | 20            | 20            | 20            | 20            | 20            | 20            | 20            | 20          |

Table 4.1.12. presents an overview of how the means of WTs vary from hour to hour after 17:00 on Sunday. It can be noticed that after 19:00 the WTs start to increase, reaching 81.3 minutes between 22:00 – 22:59. However, there appears to be a fall in the means from 23:00 – 23:59, which was less than half as busy compared to other hours.

**Table. 4.1.13. MW-U Tests on Sunday (Hungarian HGV Restrictions Impact)**

| RO -HU        | 17:00 - 17:59 | 18:00 - 18:59 | 19:00 - 19:59 | 20:00 - 20:59 | 21:00 - 21:59 | 22:00 - 22:59 | 23:00 - 23:59 | 0:00 - 0:59 |
|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|-------------|
| 17:00 - 17:59 | X             | 0.8800, No    | 0.1310, No    | 0.1664, No    | 0.0012, Yes   | 0.0100, Yes   | 0.9900, No    | 0.0960, No  |
| 18:00 - 18:59 | X             | X             | 0.0675, No    | 0.0743, No    | 0.0004, Yes   | 0.0046, Yes   | 0.9100, No    | 0.0708, No  |
| 19:00 - 19:59 | X             | X             | X             | 0.8576, No    | 0.0417, Yes   | 0.0914, No    | 0.1336, No    | 0.5274, No  |
| 20:00 - 20:59 | X             | X             | X             | X             | 0.0266, Yes   | 0.0988, No    | 0.1888, No    | 0.3901, No  |
| 21:00 - 21:59 | X             | X             | X             | X             | X             | 0.9817, No    | 0.0047, Yes   | 0.9352, No  |
| 22:00 - 22:59 | X             | X             | X             | X             | X             | X             | 0.0189, Yes   | 0.8367, No  |
| 23:00 - 23:59 | X             | X             | X             | X             | X             | X             | X             | 0.1078, No  |
| 0:00 - 0:59   | X             | X             | X             | X             | X             | X             | X             | X           |

Concurrently, Table 4.1.13 presents the *p* values for hours compared and whether there is a statistical significance have been observed. Based on the MW-U tests statistical significance has not been observed between the hours from 17:00 - 20:59. However, 21:00 - 21:59 significantly differs from earlier time frames, suggesting that the queues start building in this hour. Furthermore, 23:00 - 23:59, where the low average of 35 minutes has been registered differs from 21:00 - 21:59 and 22:00 - 22:59, suggesting that indeed might be a fall in traffic flow.

#### **4.1.1.3. Inbound WTs from the hours of the day and days of the week perspective**

The Hungarian HGV Restrictions may not only impact outbound WTs but could be impacting inbound WTs to some extent. The reason for considering this is that the only time when average inbound WTs reached 30 minutes were on Saturdays from 18:01 – 23:59 (Table 4.1.14).

**Table. 4.1.14. Inbound highest average WTs**

|        | Friday        | Saturday      | Wednesday     |               |
|--------|---------------|---------------|---------------|---------------|
|        | 18:01 - 23:59 | 18:01 - 23:59 | 12:01 - 18:00 | 18:01 - 23:59 |
|        | HU - RO       | HU - RO       | HU - RO       | HU - RO       |
| Median | 20.00         | 20.00         | 20.00         | 20.00         |
| Mode   | 20.00         | 20.00         | 20.00         | 20.00         |
| Mean   | 27.74         | 30.00         | 24.39         | 26.07         |
| SD     | 21.36         | 23.06         | 14.14         | 18.64         |
| Max    | 100.00        | 100.00        | 90.00         | 90.00         |
| Min    | 20.00         | 20.00         | 20.00         | 20.00         |

As the HGV Restrictions come into force from Saturdays 22:00 (CET), drivers may aim to get to the border before the restrictions take effect, to continue their journey in Romania. Therefore, the four time-frames with longest averages including Saturdays 18:01 – 23:59 have been tested.

**Table 4.1.15. M-WU test on IB times with the longest averages**

| HU - RO           | Fri 18:01 - 23:59 | Sat 18:01 - 23:59 | Wed 18:01 - 23:59 | Wed 12:01 - 18:00 |
|-------------------|-------------------|-------------------|-------------------|-------------------|
| Fri 18:01 - 23:59 | X                 | 0.6809, No        | 0.1078, No        | 0.1697, No        |
| Sat 18:01 - 23:59 | X                 | X                 | 0.0780, No        | 0.0780, No        |
| Wed 18:01 - 23:59 | X                 | X                 | X                 | 0.9969, No        |
| Wed 12:01 - 18:00 | X                 | X                 | X                 | X                 |

Table 4.1.15 presents that there is no statistical difference between the IB times, according to the M-WU test. Consequently, the HGV Restrictions do not significantly impact on IB WTs, as the other time frames values do not differ meaningfully.

#### **4.1.2. WTs from the weeks of the months and months of the year perspective**

In the five-month period from November 2017 to March 2018, 21 entire weeks have occurred, consequently, the data is categorised in a 21-week table. The full list of weeks including times is attached to the Appendix 2 section.

#### 4.1.2.1. Outbound busiest weeks

The four most agglomerated weeks based on the means for outbound are presented in the Table 4.1.16.

**Table 4.1.16. Four busiest weeks for OB based on the means**

|        | 18 - 24<br>March 2018 | 11 - 17<br>March 2018 | 19 - 25 Nov<br>2017 | 12 - 18 Nov<br>2017 |
|--------|-----------------------|-----------------------|---------------------|---------------------|
|        | RO -HU                | RO -HU                | RO -HU              | RO -HU              |
| Median | 110.00                | 40.00                 | 70.00               | 40.00               |
| Mode   | 20.00                 | 20.00                 | 40.00               | 20.00               |
| Mean   | 105.92                | 84.57                 | 82.24               | 69.82               |
| SD     | 74.06                 | 81.73                 | 51.57               | 64.45               |
| Max    | 250.00                | 250.00                | 200.00              | 220.00              |
| Min    | 20.00                 | 20.00                 | 20.00               | 20.00               |

These are considered to be on and after the second week of the previous month when a major national holiday occurs (Easter, Christmas). Both weeks of 11 -17 March and 18 - 24 March is right before Hungarian Easter and few weeks before the Romanian Easter. The week starting on the 12th and 19th November appear to be third and fourth busiest weeks which is followed by 26 – 02 December with an average outbound WTs of 66.42 minutes (Appendix 2). It has to be noted that in this time period (26 – 02 December) occur the busiest shopping days worldwide, such as Black Friday and Cyber Monday. Certainly, these events have not only affected the week when it has occurred, but the previous weeks as logistics activities and replenishing of stocks take place well before such events happen.

The average outbound WTs seems to drop to 50.49 minutes from the second week of December, reaching 20 minutes with 0 minutes standard deviation by the last week of December (24 – 30 December), accounting for the quietest week from the five-month time-frame due to the holiday period (Appendix 2). Similarly, statistical tests have been executed in order to observe whether there are any differences between the four most agglomerated weeks discussed.

**Table. 4.1.17. M-WU Tests on the four busiest weeks for OB (Based on the mean values)**

| RO -HU        | 18 - 24 March | 11- 17 March | 19 - 25 Nov | 12 - 18 Nov |
|---------------|---------------|--------------|-------------|-------------|
| 18 - 24 March | X             | 0.0233, Yes  | 0.0949, No  | 0.0059, Yes |
| 11- 17 March  | X             | X            | 0.1083, No  | 0.8316, No  |
| 19 - 25 Nov   | X             | X            | X           | 0.0557, No  |
| 12 - 18 Nov   | X             | X            | X           | X           |

Table. 4.1.17 presents that 18-24 March, statistically differs from 11-17 March and 12-18 Nov. Since, 18-24 March is the only variable which significantly varies from two other variables, and it is also the week with highest mean thus, it suggests that could be the week when WTs were the longest for OB.

#### **4.1.2.2. Inbound busiest weeks**

The four most agglomerated weeks based on the means for IB are presented in the Table 4.1.17.

**Table 4.1.17. The four busiest weeks for IB**

|        | 11 - 17<br>March 2018 | 10 - 16 Dec<br>2017 | 25 -31<br>March 2018 | 12 -18 Nov<br>2017 |
|--------|-----------------------|---------------------|----------------------|--------------------|
|        | HU - RO               | HU - RO             | HU - RO              | HU - RO            |
| Median | 20.00                 | 20.00               | 20.00                | 20.00              |
| Mode   | 20.00                 | 20.00               | 20.00                | 20.00              |
| Mean   | 34.20                 | 31.79               | 26.28                | 22.73              |
| SD     | 25.34                 | 19.69               | 18.98                | 4.89               |
| Max    | 100.00                | 90.00               | 100.00               | 40.00              |
| Min    | 20.00                 | 20.00               | 20.00                | 20.00              |

Interestingly, 11-17 March and 12-18 Nov appeared within the top four of the busiest weeks for OB. This proposes that busy periods such as Christmas, Easter, impact on the traffic to some extent on both sides. The mean for IB in the five-month period has only exceeded 30 minutes twice from a week perspective, as it is illustrated in the Table 4.1.17.

**Table 4.1.18. M-WU Tests on the four busiest IB weeks**

| HU - RO      | 11- 17 March | 10 - 16 Dec | 25- 31 March | 12 - 18 Nov |
|--------------|--------------|-------------|--------------|-------------|
| 11- 17 March | X            | 0.5814, No  | 0.0022, Yes  | 0.0740, No  |
| 10 - 16 Dec  | X            | X           | <0.0001, Yes | 0.0120, Yes |
| 25- 31 March | X            | X           | X            | 0.0907, No  |
| 12 - 18 Nov  | X            | X           | X            | X           |

Table 4.1.18 presents that 25-31 March significantly differs from 11-17 March and 10-16 Dec. Similarly, the M-WU test demonstrated statistical significance between 10-16 Dec vs 12-18 Nov.

#### 4.1.2.3. IB and OB WTs from months perspective

In Table 4.1.19. the data was broken down by months which further indicates that in November 2017 and March 2018, drivers experienced the longest average WTs. On the other hand, December 2017 and January 2018 was steady in overall for OB, but from February WTs began to increase and by March almost doubled, compared to the times in December.

**Table 4.1.19. Descriptive statistics on IB and OB of the months of data capturing**

|        | Nov-17  |        | Dec-17  |        | Jan-18  |        | Feb-18  |        | Mar-18  |        |
|--------|---------|--------|---------|--------|---------|--------|---------|--------|---------|--------|
|        | HU - RO | RO -HU | HU - RO | RO -HU | HU - RO | RO -HU | HU - RO | RO -HU | HU - RO | RO -HU |
| Median | 20.00   | 50.00  | 20.0    | 20.0   | 20.00   | 20.00  | 20.0    | 30.0   | 20.00   | 40.00  |
| Mode   | 20.00   | 20.00  | 20.0    | 20.0   | 20.00   | 20.00  | 20.0    | 20.0   | 20.00   | 20.00  |
| Mean   | 23.36   | 72.37  | 22.8    | 35.0   | 20.25   | 36.72  | 20.2    | 43.9   | 25.48   | 69.63  |
| SD     | 11.85   | 54.50  | 10.2    | 26.7   | 1.91    | 25.82  | 1.4     | 29.3   | 16.48   | 64.58  |
| Max    | 100.00  | 260.00 | 90.0    | 160.0  | 40.00   | 150.00 | 30.0    | 115.0  | 100.00  | 250.00 |
| Min    | 20.00   | 20.00  | 20.0    | 20.0   | 20.00   | 20.00  | 20.0    | 20.0   | 20.00   | 10.00  |

**Table 4.1.20. M-WU Test on IB WT's on months**

| HU – RO | Nov | Dec        | Jan          | Feb          | March        |
|---------|-----|------------|--------------|--------------|--------------|
| Nov     | X   | 0.5773, No | <0.0001, Yes | <0.0001, Yes | 0.7945, No   |
| Dec     | X   | X          | <0.0001, Yes | <0.0001, Yes | 0.2605, No   |
| Jan     | X   | X          | X            | 0.9115, No   | <0.0001, Yes |
| Feb     | X   | X          | X            | X            | <0.0001, Yes |
| March   | X   | X          | X            | X            | X            |

Table 4.1.20 presents that January and February significantly differ from every other month, except each other. They are the only months where the mean did not exceed 20 minutes. Therefore, it can be concluded that January and February account for the quietest month for IB traffic from the five months period. Concurrently, November, December and March did not differ significantly from each other.

**Table 4.1.21. M-WU Test on OB WT's on the months**

| RO -HU | Nov | Dec          | Jan          | Feb          | March        |
|--------|-----|--------------|--------------|--------------|--------------|
| Nov    | X   | <0.0001, Yes | <0.0001, Yes | <0.0001, Yes | 0.0299, No   |
| Dec    | X   | X            | 0.1656, No   | <0.0001, Yes | <0.0001, Yes |
| Jan    | X   | X            | X            | 0.0007, No   | <0.0001, Yes |
| Feb    | X   | X            | X            | X            | 0.0010, No   |
| March  | X   | X            | X            | X            | X            |

Table 4.1.21 reveals that WT's registered in November for OB substantially vary from every other month (except March, where WT's were the second highest). Similarly, December has also differed from the other months (except January). Furthermore, January varied from November and March, whereas February notably differed from November, December and almost reached the statistical significance level with March. As the mean times suggest that November and March are the busiest months, the M-WU tests further lead towards this conclusion.

## 4.2. Questionnaire

A total of 171 questionnaires have been completed by hauliers at the B-A BCP. All responses were gathered on the Romanian side of the border. The initial plan was to obtain responses equally from both sides of the border, to strengthen the insights the survey provides and enable capturing information and potential differences. However, the queues on the Hungarian side were not as long as on the Romanian side and it was concluded that drivers would not have sufficient time to complete the questionnaires, since the queue was steadily moving during each time of data collection.

In the next subsection, some descriptive statistics will provide basic description and simple measures about the respondents. The following issues will be discussed: drivers' nationalities, whether they are locally based, their frequency of crossings, the average of WT's and the reasons for delays revealed by the drivers.

### 4.2.1. Descriptive Phase

Table 4.2.1. Driver's nationality crosstabulation with Local People

| Driver's nationality * Local People Crosstabulation |                               |                               | Local People |        | Total  |
|-----------------------------------------------------|-------------------------------|-------------------------------|--------------|--------|--------|
|                                                     |                               |                               | Yes          | No     |        |
| Driver's nationality                                | Romanian                      | Count                         | 50           | 47     | 97     |
|                                                     |                               | % within Driver's nationality | 51.5%        | 48.5%  | 100.0% |
|                                                     |                               | % within Local People         | 80.6%        | 44.8%  | 58.1%  |
|                                                     | Hungarian                     | Count                         | 11           | 31     | 42     |
|                                                     |                               | % within Driver's nationality | 26.2%        | 73.8%  | 100.0% |
|                                                     |                               | % within Local People         | 17.7%        | 29.5%  | 25.1%  |
|                                                     | Polish                        | Count                         | 1            | 27     | 28     |
|                                                     |                               | % within Driver's nationality | 3.6%         | 96.4%  | 100.0% |
|                                                     |                               | % within Local People         | 1.6%         | 25.7%  | 16.8%  |
| Total                                               | Count                         |                               | 62           | 105    | 167    |
|                                                     | % within Driver's nationality |                               | 37.1%        | 62.9%  | 100.0% |
|                                                     | % within Local People         |                               | 100.0%       | 100.0% | 100.0% |

Table 4.2.1. shows that there were 97 Romanian respondents which accounts to 58.1% of the data, 42 Hungarians (25.1%) and 28 Polish (16.8%). Considering the nature of this BCP would be expected that Romanians and Hungarians are somewhere near evenly balanced out in numbers, but seemingly this is not the case.

Furthermore, Table 4.2.1. also reveals that 62 drivers (37.1%) live within a 100 km radius to this BCP. The reason behind asking this question was to examine whether the gravitational pool of the two nearby large cities (Oradea and Debrecen) generates an impact on the traffic at this BCP. The result of 37.1% indicates that this may contribute to some extent to the agglomeration of this BCP. Concurrently, this BCP is also a preferred choice for not local freight transporters either accounting for 62.9% of the population.

The demographics of the locally based drivers also reveals an important insight about the respondents. 80.6% of the locally living drivers are Romanian, while only 26.2% are Hungarian. These findings indicate that from the locally based population Romanian drivers are the ones who predominantly use this BCP.

**Table 4.2.2. Frequency of Crossing crosstabulation with Local People**

| Frequency of crossing * Local People Crosstabulation |                                |                                | Local People |        | Total  |
|------------------------------------------------------|--------------------------------|--------------------------------|--------------|--------|--------|
|                                                      |                                |                                | Yes          | No     |        |
| Frequency of crossing                                | 2-5                            | Count                          | 20           | 50     | 70     |
|                                                      |                                | % within Frequency of crossing | 28.6%        | 71.4%  | 100.0% |
|                                                      |                                | % within Local People          | 32.3%        | 47.6%  | 41.9%  |
|                                                      | 6-10                           | Count                          | 10           | 29     | 39     |
|                                                      |                                | % within Frequency of crossing | 25.6%        | 74.4%  | 100.0% |
|                                                      |                                | % within Local People          | 16.1%        | 27.6%  | 23.4%  |
|                                                      | 11-20                          | Count                          | 13           | 10     | 23     |
|                                                      |                                | % within Frequency of crossing | 56.5%        | 43.5%  | 100.0% |
|                                                      |                                | % within Local People          | 21.0%        | 9.5%   | 13.8%  |
|                                                      | Over 20                        | Count                          | 19           | 16     | 35     |
|                                                      |                                | % within Frequency of crossing | 54.3%        | 45.7%  | 100.0% |
|                                                      |                                | % within Local People          | 30.6%        | 15.2%  | 21.0%  |
| Total                                                | Count                          | 62                             | 105          | 167    |        |
|                                                      | % within Frequency of crossing | 37.1%                          | 62.9%        | 100.0% |        |
|                                                      | % within Local People          | 100.0%                         | 100.0%       | 100.0% |        |

Table 4.2.2 presents that 70 drivers (41.9%) crossed this BCP within the past month between 2-5 times. From these 70 respondents, 20 drivers (28.1%) are locally based, while 50 drivers (71.4%) do not live within a 100km radius. Similarly, the numbers are still quite high for not locally based drivers in the next group (6-10) with 29 responses (27.6%) within local people. However, in the 11-20 and over 20 groups, locally based drivers are the ones who slightly take over. Therefore, it emerges from the data that locally based drivers are crossing this BCP more frequently than those who do not live within a 100km radius.

**Table 4.2.3. Statistics of Average WTs**

|                       |         |          |
|-----------------------|---------|----------|
| Average crossing time |         |          |
| N                     | Valid   | 169      |
|                       | Missing | 0        |
| Mean                  |         | 201.4793 |
| Median                |         | 180.0000 |
| Std. Deviation        |         | 84.83830 |
| Range                 |         | 470.00   |
| Minimum               |         | 30.00    |
| Maximum               |         | 500.00   |

Table 4.2.3 provides the statistics based on the results of the second question, which evaluates the average WTs experienced by the drivers crossing the B-A BCP. 169 drivers provided an answer to this question, which resulted in an average of 201.48 minutes with a standard deviation of 84.83 minutes. Undoubtedly, there is an immense difference between the survey and the questionnaire results regarding WTs. Considering the five-month period of data collection, the average WTs rarely reached 200 minutes. However, the survey revealed that from 18 – 24<sup>th</sup> March 2018 was the busiest week for outbound, registering 105.92 minutes in average for crossing. The questionnaire data collection occurred between 26 - 28<sup>th</sup> March 2018. Therefore, several drivers might have focused on their negative experiences due to that busy period which might have generated an impact on the results. Furthermore, the drivers might be considering the duration of the whole border crossing process, while the RBP only refers to the time spend from the end of the queue to the beginning. This identifies the need for further research which observes the times for control procedures.

Another explanation for the sharp differences in the average WTs between the survey and the questionnaire was communicated by several truck drivers. They wrote on the questionnaire that WTs on the website 'are not realistic', 'are a lie', 'are not reliable', as these are typically longer in reality. Few of them also noted that these times must be doubled and then might reflect the reality to some extent.

**Table 4.2.4. Reason of Delays**

| Reasons of delays |                         | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------------------|-------------------------|-----------|---------|---------------|--------------------|
| Valid             | Control of Good         | 25        | 14.9    | 14.9          | 14.9               |
|                   | Lack of Border Control  | 27        | 16.1    | 16.1          | 31.0               |
|                   | Documentation check     | 36        | 21.4    | 21.4          | 52.4               |
|                   | Infrastructure problems | 80        | 47.6    | 47.6          | 100.0              |
|                   | Total                   | 168       | 100.0   | 100.0         |                    |

Table 4.2.4. reveals drivers' opinion about the cause of delays at B-A BCP. As a reason, infrastructure problems account for nearly half of the responses (47.6%), which is followed by the documentation check procedures. Indeed, on both inbound and outbound sides, there is only one lane provided to queue for trucks, which makes it impossible for EU and non-EU trucks to wait in line accordingly. However, the same infrastructure setting occurs on the inbound side where the average WT's were considerably less, according to the survey results. In order to further analyse the reason for delays, more information would be required on border control processes, as procedures may differ entering Schengen territory than exiting.

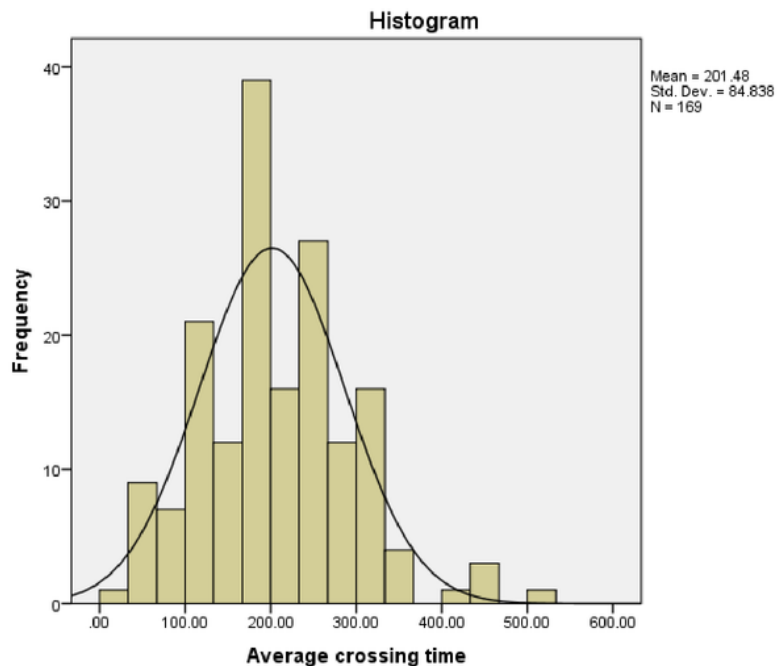
In the next subsection, further insights are aimed to be extracted from the questionnaire with the support of statistical tests.

#### **4.2.2. Testing Phase**

In this section, groups of two opposing hypotheses are proposed and tested about the population, applying Chi-Square Test ( $\chi^2$ ) and Independent Sample t-test. The first hypotheses to be tested requires Independent Sample t-test, as the differences in the mean value are evaluated. However, first the normality of the data must be evaluated. In the SPSS, this have been observed by creating a histogram graph with a bell-shaped curve.

As Figure 4.2.5 presents, the data may not perfectly normally distributed but presents the form of a bell shape, with most of the frequency counts positioned in the middle. Therefore, an Independent Sample *t*-test is used to test whether there is a difference between average crossing of non-priority goods and average crossing time of priority goods.

Figure 4.2.5 Average crossing time histogram



*H*<sub>0</sub>: There is no difference between average crossing times of non-priority goods and average crossing times of priority goods.

*H*<sub>a</sub>: There is a difference between average crossing times of non-priority goods and average crossing times of priority goods.

Table. 4.2.6. Independent *t*-test on Priority/Non-Priority goods

| Group Statistics      |             |            |     |          |                |                 |  |  |  |
|-----------------------|-------------|------------|-----|----------|----------------|-----------------|--|--|--|
|                       |             | Priorities | N   | Mean     | Std. Deviation | Std. Error Mean |  |  |  |
| Average crossing time | Priority    |            | 51  | 204.0000 | 80.57667       | 11.28299        |  |  |  |
|                       | NonPriority |            | 117 | 198.2564 | 84.14142       | 7.77888         |  |  |  |

| Independent Samples Test |                             |                                         |      |                              |        |                 |                 |                       |                                           |
|--------------------------|-----------------------------|-----------------------------------------|------|------------------------------|--------|-----------------|-----------------|-----------------------|-------------------------------------------|
|                          |                             | Levene's Test for Equality of Variances |      | t-test for Equality of Means |        |                 |                 |                       |                                           |
|                          |                             | F                                       | Sig. | t                            | df     | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |
|                          |                             |                                         |      |                              |        |                 |                 |                       | Lower Upper                               |
| Average crossing time    | Equal variances assumed     | .298                                    | .586 | .412                         | 166    | .681            | 5.74359         | 13.94097              | -21.78087 33.26805                        |
|                          | Equal variances not assumed |                                         |      | .419                         | 99.171 | .676            | 5.74359         | 13.70463              | -21.44878 32.93596                        |

As the *p*-value (Sig.) of Levene's test is .586, which suggests that the variances between the two groups are equal, due to  $p > .05$ . Consequently, the output for the *t*-test will be in the "Equal variances assumed" row, where the *t*-value and Sig. (2-tailed) must be observed in order to make conclusions. As  $t(166) = .412$ ,  $p = .681$  the null hypothesis will be accepted. This states there is no significant difference between the average crossing time of priority loads (livestock, perishable, refrigerated, explosive and flammable goods) and non-priority loads. According to the RBP (2018), lorries transporting one of these loads must not be lining in the queue, since they have the right to proceed ahead of the queue to cross in the shortest possible time. However, as several drivers reported during the questionnaire distribution, that the border police officers (including Romanian and Hungarian), force drivers to stay on the line, regardless of what they transport. The only exception when drivers can jump ahead of the queue is when border police officers are bribed (written by Hungarian and Polish drivers on the questionnaire sheets). This finding is certainly critical in many perspectives and would necessitate additional research in order to gain more clarity about the specifics.

During the testing of additional hypotheses, Chi-Square ( $\chi^2$ ) will be used, examining the association between variables.

*H0*: There is no difference between driver's awareness of the RBP website transporting non-priority goods and driver's awareness of the RBP website transporting priority goods.

*Ha*: There is a difference between driver's awareness of the RBP website transporting non-priority goods and driver's awareness of the RBP website transporting priority goods.

Table 4.2.7. Chi-Square ( $\chi^2$ ) test on Awareness of WT on RBP/Priority

| Priorities * Awareness of WT on RBP Crosstabulation |                                 |                                 |                        |        |        |
|-----------------------------------------------------|---------------------------------|---------------------------------|------------------------|--------|--------|
|                                                     |                                 |                                 | Awareness of WT on RBP |        | Total  |
|                                                     |                                 |                                 | Yes                    | No     |        |
| Priorities                                          | Priority                        | Count                           | 30                     | 21     | 51     |
|                                                     |                                 | Expected Count                  | 24.0                   | 27.0   | 51.0   |
|                                                     |                                 | % within Priorities             | 58.8%                  | 41.2%  | 100.0% |
|                                                     |                                 | % within Awareness of WT on RBP | 38.0%                  | 23.6%  | 30.4%  |
|                                                     | NonPriority                     | Count                           | 49                     | 68     | 117    |
|                                                     |                                 | Expected Count                  | 55.0                   | 62.0   | 117.0  |
|                                                     |                                 | % within Priorities             | 41.9%                  | 58.1%  | 100.0% |
|                                                     |                                 | % within Awareness of WT on RBP | 62.0%                  | 76.4%  | 69.6%  |
| Total                                               | Count                           | 79                              | 89                     | 168    |        |
|                                                     | Expected Count                  | 79.0                            | 89.0                   | 168.0  |        |
|                                                     | % within Priorities             | 47.0%                           | 53.0%                  | 100.0% |        |
|                                                     | % within Awareness of WT on RBP | 100.0%                          | 100.0%                 | 100.0% |        |

| Chi-Square Tests                   |                    |    |                                          |                          |                          |
|------------------------------------|--------------------|----|------------------------------------------|--------------------------|--------------------------|
|                                    | Value              | df | Asymptotic<br>Significance (2-<br>sided) | Exact Sig. (2-<br>sided) | Exact Sig. (1-<br>sided) |
| Pearson Chi-Square                 | 4.093 <sup>a</sup> | 1  | .043                                     |                          |                          |
| Continuity Correction <sup>b</sup> | 3.441              | 1  | .064                                     |                          |                          |
| Likelihood Ratio                   | 4.100              | 1  | .043                                     |                          |                          |
| Fisher's Exact Test                |                    |    |                                          | .046                     | .032                     |
| Linear-by-Linear Association       | 4.069              | 1  | .044                                     |                          |                          |
| N of Valid Cases                   | 168                |    |                                          |                          |                          |

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 23.98.

b. Computed only for a 2x2 table

The result ( $\chi^2 = 4.093$ ,  $p = .043$ ,  $df = 1$ ) indicates the null hypothesis will be rejected. Consequently, there is a difference between drivers' awareness of the RBP website of priority goods and driver's awareness of the RBP website of non-priority goods.

Drivers from the priority group are more aware of the RBP website and its features than those who don't transport priority loads. This may be because these drivers are more significantly impacted by longer WT's than others not transporting any priority loads. For instance, those drivers who transport livestock would not want to put the animals under the stress of queuing long times at the border. It is difficult to accept it as true that such a phenomenon occurs in the EU. However, the drivers and the questionnaire are serve as an evidence.

*H0*: There is no difference between driver's nationality experiencing delays from 18:00 – 0:00 and driver's nationality not experiencing delays from 18:00 – 0:00.

*Ha*: There is a difference between driver's nationality experiencing delays from 18:00 – 0:00 and driver's nationality not experiencing delays from 18:00 – 0:00.

**Table 4.2.8. Chi-Square ( $\chi^2$ ) test on Driver's nationality and 18:00 – 0:00**

| Driver's nationality * 18:00 - 0:00 Crosstabulation |                               |                               |              |        |        |
|-----------------------------------------------------|-------------------------------|-------------------------------|--------------|--------|--------|
|                                                     |                               |                               | 18:00 - 0:00 |        | Total  |
|                                                     |                               |                               | Yes          | No     |        |
| Driver's nationality                                | Romanian                      | Count                         | 26           | 72     | 98     |
|                                                     |                               | Expected Count                | 30.9         | 67.1   | 98.0   |
|                                                     |                               | % within Driver's nationality | 26.5%        | 73.5%  | 100.0% |
|                                                     |                               | % within 18:00 - 0:00         | 49.1%        | 62.6%  | 58.3%  |
|                                                     | Hungarian                     | Count                         | 7            | 35     | 42     |
|                                                     |                               | Expected Count                | 13.3         | 28.8   | 42.0   |
|                                                     |                               | % within Driver's nationality | 16.7%        | 83.3%  | 100.0% |
|                                                     |                               | % within 18:00 - 0:00         | 13.2%        | 30.4%  | 25.0%  |
|                                                     | Polish                        | Count                         | 20           | 8      | 28     |
|                                                     |                               | Expected Count                | 8.8          | 19.2   | 28.0   |
|                                                     |                               | % within Driver's nationality | 71.4%        | 28.6%  | 100.0% |
|                                                     |                               | % within 18:00 - 0:00         | 37.7%        | 7.0%   | 16.7%  |
| Total                                               | Count                         | 53                            | 115          | 168    |        |
|                                                     | Expected Count                | 53.0                          | 115.0        | 168.0  |        |
|                                                     | % within Driver's nationality | 31.5%                         | 68.5%        | 100.0% |        |
|                                                     | % within 18:00 - 0:00         | 100.0%                        | 100.0%       | 100.0% |        |

| Chi-Square Tests             |                     |    |                                   |
|------------------------------|---------------------|----|-----------------------------------|
|                              | Value               | df | Asymptotic Significance (2-sided) |
| Pearson Chi-Square           | 26.071 <sup>a</sup> | 2  | .000                              |
| Likelihood Ratio             | 24.724              | 2  | .000                              |
| Linear-by-Linear Association | 12.296              | 1  | .000                              |
| N of Valid Cases             | 168                 |    |                                   |

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.83.

The result ( $\chi^2 = 26.071$ ,  $p < .000$ ,  $df = 2$ ) indicates the null hypothesis will be rejected. Therefore, there is a difference between the driver's nationality experiencing delays from 18:00 – 0:00 and driver's nationality not experiencing delays from 18:00 – 0:00. Majority of Hungarians (83.3%) and Romanians (73.5%) did not experience delays in this time frame, as they supposedly do not travel in these hours. However, 71.4% of Polish drivers experienced delays, meaning that they are still on the road during these hours.

Consequently, it can be suggested that the demography of the population at B-ABCP varies depending on the hours of the days.

*H0*: There is no difference between the drivers' nationality experiencing delays on Monday and driver's nationality not experiencing delays on Monday.

*Ha*: There is a difference between driver's nationality experiencing delays on Monday and driver's nationality not experiencing delays on Monday.

Table 4.2.9. Chi-Square ( $\chi^2$ ) test on Driver's nationality and Monday

| Driver's nationality * Monday Crosstabulation |                               |                               |        |        |        |
|-----------------------------------------------|-------------------------------|-------------------------------|--------|--------|--------|
|                                               |                               |                               | Monday |        | Total  |
|                                               |                               |                               | Yes    | No     |        |
| Driver's nationality                          | Romanian                      | Count                         | 83     | 15     | 98     |
|                                               |                               | Expected Count                | 79.9   | 18.1   | 98.0   |
|                                               |                               | % within Driver's nationality | 84.7%  | 15.3%  | 100.0% |
|                                               |                               | % within Monday               | 60.6%  | 48.4%  | 58.3%  |
|                                               | Hungarian                     | Count                         | 38     | 4      | 42     |
|                                               |                               | Expected Count                | 34.3   | 7.8    | 42.0   |
|                                               |                               | % within Driver's nationality | 90.5%  | 9.5%   | 100.0% |
|                                               |                               | % within Monday               | 27.7%  | 12.9%  | 25.0%  |
|                                               | Polish                        | Count                         | 16     | 12     | 28     |
|                                               |                               | Expected Count                | 22.8   | 5.2    | 28.0   |
|                                               |                               | % within Driver's nationality | 57.1%  | 42.9%  | 100.0% |
|                                               |                               | % within Monday               | 11.7%  | 38.7%  | 16.7%  |
| Total                                         | Count                         |                               | 137    | 31     | 168    |
|                                               | Expected Count                |                               | 137.0  | 31.0   | 168.0  |
|                                               | % within Driver's nationality |                               | 81.5%  | 18.5%  | 100.0% |
|                                               | % within Monday               |                               | 100.0% | 100.0% | 100.0% |

Chi-Square Tests

|                              | Value               | df | Asymptotic<br>Significance (2-<br>sided) |
|------------------------------|---------------------|----|------------------------------------------|
| Pearson Chi-Square           | 13.952 <sup>a</sup> | 2  | .001                                     |
| Likelihood Ratio             | 12.125              | 2  | .002                                     |
| Linear-by-Linear Association | 6.709               | 1  | .010                                     |
| N of Valid Cases             | 168                 |    |                                          |

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.17.

The result ( $\chi^2 = 13.952$ ,  $p < .001$ ,  $df = 2$ ) indicates there is evidence to reject the null hypothesis in favour of the alternate, as there is a high statistical difference between drivers' nationality experiencing delays on Monday and driver's nationality not experiencing delays on Monday.

Similarly, Romanian and Hungarian drivers are the ones who predominantly experience delays on Mondays. Again, the responses of Polish drivers are quite divided. This can be due also to the same factor that the population of this BCP changes, not only by hours of the day but also days of the week. It can be suggested that Polish drivers may travel in limited numbers through this BCP on Monday if they start their journey in Poland on Monday. Furthermore, the Hungarian Sunday HGV Restrictions limits these drivers to do not travel on a Sunday. This phenomenon was also noticed during the questionnaire distribution, as more Polish drivers filled out the questionnaires on Wednesday compared to Monday.

H0: There is no difference between the reason of delays within those drivers who experienced delays from 18:00 – 0:00 and the reason of delays within those drivers who did not experience delays from 18:00 – 0:00.

Ha: There is a difference between the reason of delays within those drivers who experienced delays from 18:00 – 0:00 and the reason of delays within those drivers who did not experience delays from 18:00 – 0:00.

Table 4.2.9. Chi-Square ( $\chi^2$ ) test on reason of delays and 18:00 – 0:00

| Reasons of delays * 18:00 - 0:00 Crosstabulation |                        |                            |              |       |        |
|--------------------------------------------------|------------------------|----------------------------|--------------|-------|--------|
|                                                  |                        |                            | 18:00 - 0:00 |       | Total  |
|                                                  |                        |                            | Yes          | No    |        |
| Reasons of delays                                | Control of Goods       | Count                      | 6            | 19    | 25     |
|                                                  |                        | Expected Count             | 7.9          | 17.1  | 25.0   |
|                                                  |                        | % within Reasons of delays | 24.0%        | 76.0% | 100.0% |
|                                                  |                        | % within 18:00 - 0:00      | 11.3%        | 16.5% | 14.9%  |
|                                                  | Lack of Border Control | Count                      | 12           | 15    | 27     |
|                                                  |                        | Expected Count             | 8.5          | 18.5  | 27.0   |
|                                                  |                        | % within Reasons of delays | 44.4%        | 55.6% | 100.0% |
|                                                  |                        | % within 18:00 - 0:00      | 22.6%        | 13.0% | 16.1%  |
|                                                  | Documentation check    | Count                      | 5            | 31    | 36     |
|                                                  |                        | Expected Count             | 11.4         | 24.6  | 36.0   |
|                                                  |                        | % within Reasons of delays | 13.9%        | 86.1% | 100.0% |
|                                                  |                        | % within 18:00 - 0:00      | 9.4%         | 27.0% | 21.4%  |

|                         |                            |        |        |        |
|-------------------------|----------------------------|--------|--------|--------|
| Infrastructure problems | Count                      | 30     | 50     | 80     |
|                         | Expected Count             | 25.2   | 54.8   | 80.0   |
|                         | % within Reasons of delays | 37.5%  | 62.5%  | 100.0% |
|                         | % within 18:00 - 0:00      | 56.6%  | 43.5%  | 47.6%  |
| Total                   | Count                      | 53     | 115    | 168    |
|                         | Expected Count             | 53.0   | 115.0  | 168.0  |
|                         | % within Reasons of delays | 31.5%  | 68.5%  | 100.0% |
|                         | % within 18:00 - 0:00      | 100.0% | 100.0% | 100.0% |

| Chi-Square Tests             |                    |    |                                   |
|------------------------------|--------------------|----|-----------------------------------|
|                              | Value              | df | Asymptotic Significance (2-sided) |
| Pearson Chi-Square           | 9.250 <sup>a</sup> | 3  | .026                              |
| Likelihood Ratio             | 9.955              | 3  | .019                              |
| Linear-by-Linear Association | .568               | 1  | .451                              |
| N of Valid Cases             | 168                |    |                                   |

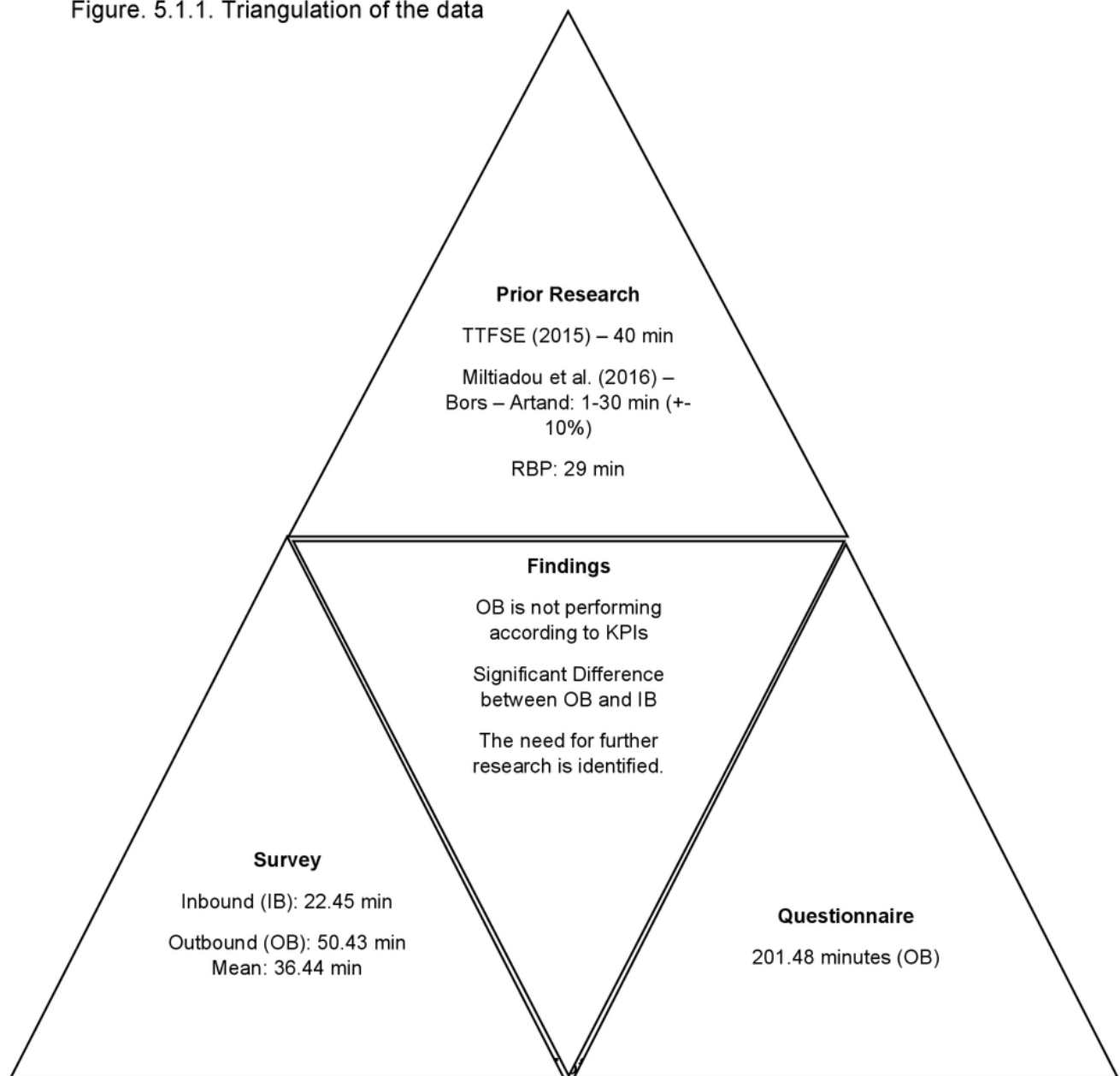
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.89.

The result ( $\chi^2 = 9.250$ ,  $p < .026$ ,  $df = 3$ ) indicates that the null hypothesis will be rejected. Therefore, there is a statistical significance between the reason of delays within those drivers who experienced delays from 18:00 – 0:00 and the reason of delays within those drivers who did not experience delays within the same period. Earlier it has been discussed that infrastructure problems are the major problems at B-ABCP, revealed by lorry drivers. However, if this is analysed from an hour of the day perspective different results might be discovered. Since, 44.4% of the drivers declaring that lack of border control it is a reason for delays in this time-period. Consequently, reasons can also vary depending on the time when drivers cross, which would certainly require a larger dataset to discover additional insights accurately.

## Chapter 5. Conclusion

The present study attempted to explore WT<sub>s</sub> at B-A BCP through two distinct research methods providing valuable insights from two different perspectives thus attempting to get a closer understanding of reality. The triangle below (Figure.5.1.1) presents an overview of the conclusions drawn based on the data collected through prior research, and the survey and questionnaire methods employed herein.

Figure. 5.1.1. Triangulation of the data



### 5.1. Discussions of prior research, survey, questionnaire.

Equally, the survey, the questionnaire and the literature findings added value to this paper in a unique way. The research by Miltiadou et al. (2016) and TTFSE (2015) assisted in identifying WTs, based on which the B-A BCP can be assessed. The RBP's own KPIs of 29 minutes can also be added to the equation. All three together present a reality in which WTs must not exceed more than 34 minutes on average (This figure is based on the mean of the three figures reported in the literature review). Studies related to the temporary re-introduction of border controls within Schengen may also be considered which presented on average 30-60 minutes WTs. However, as Romania and Hungary are not both Schengen, these would not lead to a fair comparison. Therefore only, Miltiadou et al. (2016) who analysed the B-A BCP and TTFSE (2015) stating that between two EU countries the maximum acceptable time for clearance is 40 minutes, will be accepted along with RBP's KPIs.

The survey draws its own reality in which valuable insights are discovered about the occurrence of the longest WTs, broken down to hours, days, weeks and months. Furthermore, a statistically significant difference in WTs between the sides is notable. Since the M-WU tests and similarly the means of inbound was 22.45 minutes and outbound was 50.43 minutes indicates that from EU Non-Schengen average crossing times to EU Schengen are significantly higher. This is a critical finding which has not been considered in previously identified studies. In sum, considering the average of inbound and outbound, the survey presents a reality where WTs are 36.44 minutes at this BCP.

The questionnaire, on the other hand, draws a picture of the on-goings at this BCP which might appear quite extreme. Undoubtedly, this still can be the case, but in order to accept as reliable evidence, additional research is required. The average WTs experienced by the drivers was 201.48 minutes. Multiple factors have been considered, regarding of what may be the reason for such a long time, compared to the prior research and the survey. Drivers' opinion about the reason for delays would similarly require more investigation. Overall, the questionnaire might have opened more questions than it has answered, but these insights are equally relevant which belong to the reality of the B-A BCP, such as, driver's input about corruption and priority loads that are not receiving priority.

## 5.2. Findings and implications

There are several findings that can be taken as substantial based on the data analyses employed in this dissertation. Traffic from Romania (EU, Non-Schengen) to Hungary (EU, Schengen) experienced significantly longer WT's in the five months period. Comparing it to the WT's from the literature and inbound survey times it can be concluded that outbound necessitates improvement and more research in order to investigate the causes. The busy hours of the day, weeks and days have been revealed specifically applying to this BCP. Equally, the questionnaire results principally added value regarding the B-A BCP. Therefore, Sardar and Lee (2015) statement that border crossing complexity is the least researched area due to the subjective nature of the field is firmly agreed with. However, this paper intends to identify few aspects of the field which are ultimately not subjective.

First, distinguishing outbound and inbound traffic flows is highly recommended in every future study related to BCP's, as this can improve the accuracy of the results. Consequently, this approach can lead to increase predictability and the usefulness of the data. In the ages of just-in-time deliveries and lean, predictability is essential for organisations and in the achievement of efficient border operations. The literature review identified the value of time for freight, plus a case study by France Stratégie (2016) which revealed that a half an hour WT at BCPs in France, adds extra 56 million euros per year for the carrier costs. It is not known; how much is the exact amount of Hungary's or Romania's case. However, it is more important to consider what the TOC emphasises. One of the steps towards improvement is to fully exploit a constraint to achieve maximum effectiveness. In BCP's case, Romanians began taking steps in the right direction by developing the website which provides the WT's real-time. However, improving this system by providing a forecasting option based on the past data would do precisely what TOC discusses, reducing the variation and increasing predictability. Furthermore, as this study managed with insufficient resources to discover when delays are most likely to occur, border police authorities must be aiming to release similar information to the public to improve efficiency. The resources and the investment to develop these services is not considered very high cost, in terms of a governmental and EU resources, but the benefits are all the more.

Therefore, improvements as such would support collectively every BCP's primary goal of operation which is to play a vital role in national security, the economic prosperity of a nation and operate at maximum efficiency at all times (Eng, 2017).

### 5.3. Limitations

As a preliminary study at undergraduate level, this research managed to tap into a number of essential problems concerning WT's at BCP. However, no research is without limitations. One of the limitations of the present study is that it only surveyed a period of five months, which is acceptable and insightful for the given period, however, future studies might expand this part of the research for the whole year. Another limitation is perhaps related to all questionnaires in the social sciences. While such instruments provide valuable insights to a certain extent, drawing definitive conclusions might be difficult given the fixed multiple-choice answers, number of participants and their perception of waiting times.

### 5.4. Recommendations

Some of the findings highlighted that further research is necessitated in areas such as reason of delays, including procedural differences between crossing from Non-Schengen to Schengen. Equally, an investigation on why priority loads are forced to queue at this BCP is considered an issue with critical importance. These studies could further improve awareness, related to B-A BCP. However, the primary focus must be on reducing the bottleneck of random WT's, as these impact entire economies and the whole EU transport. Therefore, the RBP must enhance and improve their website by providing accurate WT's, with an additional forecasting feature. Furthermore, governments and logistics companies could collaborate to gather idle times from GPS systems to overcome this bottleneck and derive conclusions from a richer data.

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## List of Appendices

### Appendix 1 - Questionnaires

Hi, my name is Mark Toro, I am a final year Logistics and Supply Chain Management student at University of Wales Trinity St David. I would much appreciate few minutes of your time to complete this questionnaire, concerning with the waiting times at this border control point. Your input would significantly support my dissertation. Thank you, a lot, in advance, Mark.



**Please answer these questions considering the actual part of the border you are located.**

1. How often did you travel through this border control point in this month?

2 to 5  
6 to 10  
11 to 20  
Over 20 times

|  |
|--|
|  |
|  |
|  |
|  |

2. How long typically does it take you travel through this border control point?

|  |
|--|
|  |
|--|

minutes

3. What was the longest delay/waiting time you have experienced in the past month?

10-30 min  
31-60 minutes  
61-90 minutes  
91-120 minutes

|  |
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|  |
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|  |

121-180 minutes

|  |
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|  |
|  |

Over 181 minutes

4. Is there a specific time when delays are experienced? (Tick all that apply)

0:00 - 6:00

|  |
|--|
|  |
|--|

6:00 - 12:00

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12:00 - 18:00

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18:00 - 0:00

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|--|

5. Does the Hungarian Sunday HGV Restrictions cause delays?

Yes

|  |
|--|
|  |
|--|

No

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6. Is there a day of the week when delays are more likely to occur? (Tick all that apply)

Monday

|  |
|--|
|  |
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Tuesday

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Wednesday

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|--|
|  |
|--|

Thursday

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Friday

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|  |
|--|

Saturday

|  |
|--|
|  |
|--|

Sunday

|  |
|--|
|  |
|--|

7. Which of these causes the greatest delay?

Control of Goods

|  |
|--|
|  |
|--|

Lack of Border Control Staff

|  |
|--|
|  |
|--|

Documentation check

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|--|
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Infrastructure problems (Insufficient number of lanes)

|  |
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|  |
|--|

8. Are you transporting any of these?

Livestock  
Perishables  
Refrigerated goods  
Explosible Flammable Goods  
I don't transport any of these

|  |
|--|
|  |
|  |
|  |
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|  |

9. Do you live local? (Within 100km)

Yes  
No

|  |
|--|
|  |
|  |

10. Did you know that on the Romanian Border Police Website, live waiting times at the borders can be checked?

Yes  
No

|  |
|--|
|  |
|  |

Thank you for your time, have a safe journey!

### **Romanian Questionnaire**

Salut, numele meu este Mark Toro, sunt un student de logistică și de gestionare a lanțului de aprovizionare la Universitatea din Wales Trinity St David. Aș aprecia foarte mult câteva minute din timpul dvs. pentru a completa acest chestionar, referitor la timpul de așteptare la acest punct de control la frontieră. Contribuția dvs. ar susține în mod semnificativ lucrarea mea de licență. Mulțumesc mult în avans, Mark.



PRIFYSGOL CYMRU  
Y Drindod Dewi Sant  
UNIVERSITY OF WALES  
Trinity Saint David

**Răspundeți la aceste întrebări, luând în considerare partea actuala a frontierei pe care vă aflați.**

1. De câte ori ați trecut această trecere a frontierei în ultima lună?

2 - 5

☐

6-10

☐

11-20

☐

Mai mult de 20 de ori

☐

2. Cât timp durează de obicei trecerea acestui punct de a frontierei?

|  |
|--|
|  |
|--|

 minute

3. Cea mai lungă întârziere / timp de așteptare pe care l-ați experimentat în ultima luna?

10-30 minute

☐

31-60 minute

☐

61-90 minute

☐

91-120 minute

☐

121-180 minute

☐

Mai mult de 181 minute

☐

4. Exist anumite timpuri în cursul zilei cand întârzierile sunt experimentate mai des? (Bifați tot ce se aplică)

0:00 - 6:00

☐

6:00 - 12:00

☐

12:00 - 18:00

☐

18:00 - 0:00

☐

5. Restricțiile de camioane duminică din Ungaria provoacă întârzieri?

Da

☐

Nu  
Nu știu

|  |
|--|
|  |
|  |

6. Exist anumite zile în cursul săptămânii cand întârzierile sunt experimentate mai des? (Bifați tot ce se aplică)

Luni  
Marți  
Miercuri  
Joi  
Vineri  
Sămbăta  
Duminca

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7. Care dintre următoarele poate provoca întârzieri?

Controlul marfurilor  
Lipsa personalului de la garda de frontieră  
Procesul de verificare documentelor  
Probleme cu infrastructură (Nu sunt suficient benzi)

|  |
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|  |

8. Transportați unele dintre următoare?

Șeptel  
Mărfuri perisabile  
Produse Frigorifice  
Explozibil, Inflamabil  
Nu transport cele menționate de sus

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9. Locuiți la mai puțin de 100 km distanță?

Da

|  |
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|  |
|--|

Nu

☐

10. Știați că pe site-ul Poliției de Frontieră din România pot fi verificate orele de așteptare la graniță?

Da

☐

Nu

☐

Vă mulțumesc pentru timpul acordat! Drum bun în continuare!

### Hungarian Questionnaire

Jó napot, a nevem Márk Törő, egy végzős diák vagyok logisztika és ellátási lánc menedzsment szakon, a Wales Trinity St David Egyetemen. Nagyra értékelnék néhány percet az idejéből, ami alatt kitöltené ezt a kérdőívet, ami a határellenőrzési pont várakozási idejével kapcsolatos. A véleménye jelentősen támogatná a diploma munkámat. Köszönöm szépen előre is, Mark.



PRIFYSGOL CYMRU  
Y Drindod Dewi Sant  
UNIVERSITY OF WALES  
Trinity Saint David

Kérem, válaszoljon ezekre a kérdésekre figyelembe véve az oldalt amelyen tartózkodik.

1. Hányszor kelt át ezen a határátkelő helyen az utóbbi hónapban ?

2-5

☐

6-10

☐

11-20

☐

20nál többször

☐

2. Mennyi időbe telik átlagosan, hogy átkeljen ezen a határátkelő ponton?

perc

3. Leghosszabb késés/várakozási idő amit tapasztalt az utóbbi hónapban?

10-30 perc

31-60 perc

61-90 perc

91-120 perc

121-180 perc

181 percnél több

|  |
|--|
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4. Vannak-e olyan napszakok, amikor a késések tapasztalhatók? (Jelölje meg mindazt, ami érvényes)

0:00 - 6:00

6:00 - 12:00

12:00 - 18:00

18:00 - 0:00

|  |
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|  |
|  |
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|  |

5. A vasárnapi kamionstop okoz késéket?

Igen

Nem

Nem tudom

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|  |
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|  |

6. Vannak-e olyan napok amikor a késések inkább jellemzőek? (Jelölje meg mindazt ami érvényes)

Hétfő

Kedd

Szerda

Csütörtök

Péntek

Szombat

Vasárnap

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7. Az alábbiak közül melyk okozza a legnagyobb késéseket?

- Áru ellenőrzési folyamatok lassúsága
- Személyzet hiány a határőrségnél
- Dokumentum ellenőrzés
- Infrastruktúra problémák (Nincs elegendő sáv)

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8. Szállítja valamelyket az alábbiak közül?

- Állatállomány
- Romlandó árú
- Hűtött árú
- Robbanó, gyúlékony anyagok
- Nem szállítom a fent említetteket

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9. A lackíme 100 km-ren belül található?

- Igen
- Nem

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|  |
|  |

10. Tudta-e, hogy a román határőrség honlapján a várakozási idők a határokon megtekinthetőek?

- Igen
- Nem

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Köszönöm az idejét, további jó utat!

**Polish Questionnaire**

Cześć, nazywam się Mark Toro, jestem studentem ostatniego roku zarządzania logistyką i łańcuchem dostaw w University of Wales Trinity St David. Byłbym wdzięczny za poświęcenie kilku minut na wypełnienie kwestionariusza dotyczącego czasu oczekiwania w tym punkcie kontroli granicznej. Twój wkład znacznie wesprze moją rozprawę. Dziękuję bardzo z góry, Mark.

**Odpowiedz na te pytania, biorąc pod uwagę faktyczną część granicy, w której się znajdujesz.**

1. Jak często podróżowałeś przez ten punkt kontroli granicznej w tym miesiącu?

- 2-5  
6-10  
11-20  
Ponad 20 razy

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2. Jak długo zazwyczaj podróżujesz przez ten punkt kontroli granicznej?

|  |        |
|--|--------|
|  | minuty |
|--|--------|

3. Jakie było najdłuższe opóźnienie / czas oczekiwania, jakiego doświadczyłeś w poprzednim miesiącu?

- 10-30 minuty  
31-60 minuty  
61-90 minuty  
91-120 minuty  
121-180 minuty  
Ponad 181 minut

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4. Czy istnieje określony czas opóźnień? (Zaznacz wszystkie, które mają zastosowanie)

0:00 - 6:00

6:00 - 12:00

12:00 - 18:00

18:00 - 0:00

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5. Czy ograniczenia węgierskiej niedzieli powodują opóźnienia?

Zes

Nie

Nie wiem

|  |
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|  |
|  |
|  |

6. Czy istnieje dzień tygodnia, w którym prawdopodobieństwo wystąpienia opóźnień jest większe? (Zaznacz wszystkie, które mają zastosowanie)

poniedziałek

wtorek

środa

czwartek

piątek

sobota

niedziela

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7. Które z nich powoduje największe opóźnienie?

Kontrola towarów

Brak personelu kontroli granicznej

Kontrola dokumentacji

Problemy z infrastrukturą (niewystarczająca liczba pasów ruchu)

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8. Przewożysz któreś z nich?

|                                 |                          |
|---------------------------------|--------------------------|
| Żywy inwentarz                  | <input type="checkbox"/> |
| Łatwo psujące się               | <input type="checkbox"/> |
| Towary chłodnicze               | <input type="checkbox"/> |
| Materiały wybuchowe łatwopalne  | <input type="checkbox"/> |
| Nie transportuję żadnego z nich | <input type="checkbox"/> |

9. Czy mieszkasz lokalnie? (W promieniu 100 km)

|     |                          |
|-----|--------------------------|
| Zes | <input type="checkbox"/> |
| Nie | <input type="checkbox"/> |

Czy wiesz, że na stronie internetowej rumuńskiej policji granicznej można sprawdzić czas oczekiwania na żywo na granicach?

|     |                          |
|-----|--------------------------|
| Zes | <input type="checkbox"/> |
| Nie | <input type="checkbox"/> |

Dziękuję za poświęcony czas, bezpieczną podróż!

## Appendix 2 - Survey WTs

Days and hours of the week

| Days/Times | 0:00 - 6:00 |         |         | 6:01 - 12:00 |        | 12:01 - 18:00 |        | 18:01 - 23:59 |        |
|------------|-------------|---------|---------|--------------|--------|---------------|--------|---------------|--------|
| Sunday     |             | HU - RO | RO - HU | HU - RO      | RO -HU | HU - RO       | RO -HU | HU - RO       | RO -HU |
|            | Median      | 20.00   | 20.00   | 20.00        | 20.00  | 20.00         | 20.00  | 20.00         | 50.00  |
|            | Mode        | 20.00   | 20.00   | 20.00        | 20.00  | 20.00         | 20.00  | 20.00         | 20.00  |
|            | Mean        | 21.70   | 20.05   | 20.00        | 22.61  | 20.00         | 22.94  | 21.27         | 53.45  |
|            | SD          | 5.56    | 1.01    | 0.00         | 6.81   | 0.00          | 9.86   | 9.44          | 34.60  |
|            | Max         | 40.00   | 40.00   | 20.00        | 40.00  | 20.00         | 70.00  | 90.00         | 180.00 |
|            | Min         | 20.00   | 20.00   | 20.00        | 20.00  | 20.00         | 20.00  | 20.00         | 20.00  |
| Monday     |             | HU - RO | RO -HU  | HU - RO      | RO -HU | HU - RO       | RO -HU | HU - RO       | RO -HU |
|            | Median      | 20.00   | 30.00   | 20.00        | 30.00  | 20.00         | 60.00  | 20.00         | 40.00  |
|            | Mode        | 20.00   | 20.00   | 20.00        | 20.00  | 20.00         | 20.00  | 20.00         | 40.00  |
|            | Mean        | 20.00   | 52.20   | 21.38        | 53.79  | 22.45         | 77.74  | 21.04         | 65.21  |
|            | SD          | 0.00    | 49.54   | 3.95         | 49.20  | 6.17          | 65.71  | 3.71          | 49.72  |
|            | Max         | 20.00   | 180.00  | 40.00        | 200.00 | 40.00         | 240.00 | 40.00         | 190.00 |
|            | Min         | 20.00   | 20.00   | 20.00        | 20.00  | 20.00         | 20.00  | 20.00         | 20.00  |
| Tuesday    |             | HU - RO | RO -HU  | HU - RO      | RO -HU | HU - RO       | RO -HU | HU - RO       | RO -HU |
|            | Median      | 20.00   | 20.00   | 20.00        | 30.00  | 20.00         | 80.00  | 20.00         | 80.00  |
|            | Mode        | 20.00   | 20.00   | 20.00        | 20.00  | 20.00         | 20.00  | 20.00         | 110.00 |
|            | Mean        | 20.00   | 28.75   | 20.00        | 52.58  | 20.48         | 88.89  | 21.04         | 89.10  |
|            | SD          | 0.00    | 13.43   | 0.00         | 52.89  | 2.15          | 64.24  | 3.08          | 47.06  |
|            | Max         | 20.00   | 80.00   | 20.00        | 250.00 | 30.00         | 250.00 | 30.00         | 200.00 |
|            | Min         | 20.00   | 20.00   | 20.00        | 20.00  | 20.00         | 20.00  | 20.00         | 20.00  |
| Wednesday  |             | HU - RO | RO -HU  | HU - RO      | RO -HU | HU - RO       | RO -HU | HU - RO       | RO -HU |
|            | Median      | 20.00   | 30.00   | 20.00        | 70.00  | 20.00         | 100.00 | 20.00         | 70.00  |
|            | Mode        | 20.00   | 20.00   | 20.00        | 30.00  | 20.00         | 100.00 | 20.00         | 20.00  |
|            | Mean        | 20.00   | 40.55   | 24.00        | 72.00  | 24.39         | 93.51  | 26.07         | 85.66  |
|            | SD          | 0.00    | 26.97   | 12.91        | 44.56  | 14.14         | 53.12  | 18.64         | 58.45  |
|            | Max         | 20.00   | 120.00  | 70.00        | 180.00 | 90.00         | 250.00 | 90.00         | 250.00 |
|            | Min         | 20.00   | 20.00   | 20.00        | 20.00  | 20.00         | 20.00  | 20.00         | 20.00  |
| Thursday   |             | HU - RO | RO -HU  | HU - RO      | RO -HU | HU - RO       | RO -HU | HU - RO       | RO -HU |
|            | Median      | 20.00   | 20.00   | 20.00        | 30.00  | 20.00         | 70.00  | 20.00         | 40.00  |
|            | Mode        | 20.00   | 20.00   | 20.00        | 20.00  | 20.00         | 20.00  | 20.00         | 20.00  |
|            | Mean        | 21.83   | 37.67   | 20.34        | 54.07  | 21.51         | 80.00  | 22.71         | 52.29  |
|            | SD          | 7.48    | 30.05   | 1.83         | 48.64  | 4.11          | 58.51  | 7.00          | 39.75  |
|            | Max         | 60.00   | 130.00  | 30.00        | 200.00 | 40.00         | 260.00 | 60.00         | 200.00 |
|            | Min         | 20.00   | 20.00   | 20.00        | 20.00  | 20.00         | 20.00  | 20.00         | 20.00  |
| Friday     |             | HU - RO | RO -HU  | HU - RO      | RO -HU | HU - RO       | RO -HU | HU - RO       | RO -HU |
|            | Median      | 20.00   | 20.00   | 20.00        | 20.00  | 20.00         | 40.00  | 20.00         | 40.00  |
|            | Mode        | 20.00   | 20.00   | 20.00        | 20.00  | 20.00         | 40.00  | 20.00         | 20.00  |
|            | Mean        | 21.84   | 23.42   | 22.16        | 34.12  | 24.07         | 42.59  | 27.74         | 41.89  |
|            | SD          | 4.57    | 7.81    | 11.54        | 20.61  | 16.08         | 24.28  | 21.36         | 26.24  |
|            | Max         | 40.00   | 60.00   | 100.00       | 90.00  | 100.00        | 110.00 | 100.00        | 150.00 |
|            | Min         | 20.00   | 20.00   | 20.00        | 10.00  | 20.00         | 10.00  | 20.00         | 20.00  |
| Saturday   |             | HU - RO | RO -HU  | HU - RO      | RO -HU | HU - RO       | RO -HU | HU - RO       | RO -HU |
|            | Median      | 20.00   | 20.00   | 20.00        | 20.00  | 20.00         | 20.00  | 20.00         | 20.00  |
|            | Mode        | 20.00   | 20.00   | 20.00        | 20.00  | 20.00         | 20.00  | 20.00         | 20.00  |
|            | Mean        | 20.98   | 23.92   | 23.14        | 20.39  | 28.45         | 24.48  | 30.00         | 20.44  |
|            | SD          | 3.00    | 8.50    | 9.69         | 3.98   | 20.16         | 7.99   | 23.06         | 4.75   |
|            | Max         | 30.00   | 40.00   | 60.00        | 30.00  | 100.00        | 40.00  | 100.00        | 40.00  |
|            | Min         | 20.00   | 10.00   | 20.00        | 10.00  | 20.00         | 10.00  | 20.00         | 10.00  |

## Days of the week

| Monday    |        | HU - RO | RO -HU | Friday   |        | HU - RO | RO -HU |
|-----------|--------|---------|--------|----------|--------|---------|--------|
|           | Median | 20.00   | 40.00  |          | Median | 20.0    | 30.0   |
|           | Mode   | 20.00   | 20.00  |          | Mode   | 20.0    | 20.0   |
|           | Mean   | 21.29   | 58.96  |          | Mean   | 23.6    | 42.8   |
|           | SD     | 4.27    | 53.46  |          | SD     | 14.2    | 37.1   |
|           | Max    | 40.00   | 240.00 |          | Max    | 100.0   | 200.0  |
|           | Min    | 20.00   | 20.00  |          | Min    | 20.0    | 10.0   |
| Tuesday   |        | HU - RO | RO -HU | Saturday |        | HU - RO | RO -HU |
|           | Median | 20.00   | 40.00  |          | Median | 20.0    | 20.0   |
|           | Mode   | 20.00   | 20.00  |          | Mode   | 20.0    | 20.0   |
|           | Mean   | 20.43   | 66.38  |          | Mean   | 26.0    | 21.8   |
|           | SD     | 2.04    | 55.06  |          | SD     | 16.9    | 6.2    |
|           | Max    | 30.00   | 250.00 |          | Max    | 100.0   | 40.0   |
|           | Min    | 20.00   | 20.00  |          | Min    | 20.0    | 10.0   |
| Wednesday |        | HU - RO | RO -HU | Sunday   |        | HU - RO | RO -HU |
|           | Median | 20.00   | 60.00  |          | Median | 20      | 20     |
|           | Mode   | 20.00   | 20.00  |          | Mode   | 20      | 20     |
|           | Mean   | 23.75   | 73.77  |          | Mean   | 20      | 35     |
|           | SD     | 13.65   | 51.49  |          | SD     | 5       | 31     |
|           | Max    | 90.00   | 250.00 |          | Max    | 90      | 180    |
|           | Min    | 20.00   | 20.00  |          | Min    | 20      | 20     |
| Thursday  |        | HU - RO | RO -HU |          |        |         |        |
|           | Median | 20.00   | 40.00  |          |        |         |        |
|           | Mode   | 20.00   | 20.00  |          |        |         |        |
|           | Mean   | 21.81   | 54.47  |          |        |         |        |
|           | SD     | 5.94    | 47.05  |          |        |         |        |
|           | Max    | 60.00   | 260.00 |          |        |         |        |
|           | Min    | 20.00   | 20.00  |          |        |         |        |

## Weeks of the year

| 5 - 11<br>November<br>2017  |        | HU - RO | RO -HU |
|-----------------------------|--------|---------|--------|
|                             | Median | 20.00   | 55.00  |
|                             | Mode   | 20.00   | 20.00  |
|                             | Mean   | 22.40   | 61.20  |
|                             | SD     | 10.21   | 41.39  |
|                             | Max    | 90.00   | 150.00 |
|                             | Min    | 20.00   | 20.00  |
| 12 - 18<br>November<br>2017 |        | HU - RO | RO -HU |
|                             | Median | 20.00   | 40.00  |
|                             | Mode   | 20.00   | 20.00  |
|                             | Mean   | 22.73   | 69.82  |
|                             | SD     | 4.89    | 64.45  |

| 28 - 03<br>February 2018 |        | HU - RO | RO -HU |
|--------------------------|--------|---------|--------|
|                          | Median | 20.00   | 40.00  |
|                          | Mode   | 20.00   | 20.00  |
|                          | Mean   | 20.00   | 43.51  |
|                          | SD     | 0.00    | 21.42  |
|                          | Max    | 20.00   | 100.00 |
|                          | Min    | 20.00   | 20.00  |
| 04 - 10<br>February 2018 |        | HU - RO | RO -HU |
|                          | Median | 20.00   | 20.00  |
|                          | Mode   | 20.00   | 20.00  |
|                          | Mean   | 20.00   | 41.45  |
|                          | SD     | 0.00    | 29.65  |
|                          | Max    | 20.00   | 110.00 |

|                             |        |         |        |
|-----------------------------|--------|---------|--------|
|                             | Max    | 40.00   | 220.00 |
|                             | Min    | 20.00   | 20.00  |
| 19 - 25<br>November<br>2017 |        | HU - RO | RO -HU |
|                             | Median | 20.00   | 70.00  |
|                             | Mode   | 20.00   | 40.00  |
|                             | Mean   | 20.41   | 82.24  |
|                             | SD     | 2.86    | 51.57  |
|                             | Max    | 40.00   | 200.00 |
|                             | Min    | 20.00   | 20.00  |
|                             |        | HU - RO | RO -HU |
| 26 - 02<br>December<br>2017 | Median | 20.00   | 40.00  |
|                             | Mode   | 20.00   | 20.00  |
|                             | Mean   | 20.38   | 66.42  |
|                             | SD     | 2.75    | 57.15  |
|                             | Max    | 40.00   | 260.00 |
|                             | Min    | 20.00   | 20.00  |
| 03 - 09<br>December<br>2017 |        | HU - RO | RO -HU |
|                             | Median | 20.00   | 40.00  |
|                             | Mode   | 20.00   | 20.00  |
|                             | Mean   | 20.49   | 50.49  |
|                             | SD     | 2.18    | 35.81  |
|                             | Max    | 30.00   | 160.00 |
|                             | Min    | 20.00   | 20.00  |
| 10 - 16<br>December<br>2017 |        | HU - RO | RO -HU |
|                             | Median | 20.00   | 40.00  |
|                             | Mode   | 20.00   | 40.00  |
|                             | Mean   | 31.79   | 47.16  |
|                             | SD     | 19.69   | 27.46  |
|                             | Max    | 90.00   | 120.00 |
|                             | Min    | 20.00   | 20.00  |
| 17 - 23<br>December<br>2017 |        | HU - RO | RO -HU |
|                             | Median | 20.00   | 20.00  |
|                             | Mode   | 20.00   | 20.00  |
|                             | Mean   | 21.20   | 28.11  |
|                             | SD     | 3.26    | 17.33  |
|                             | Max    | 30.00   | 110.00 |
|                             | Min    | 20.00   | 20.00  |
| 24 - 30<br>December<br>2017 |        | HU - RO | RO -HU |
|                             | Median | 20.00   | 20.00  |
|                             | Mode   | 20.00   | 20.00  |

|                             |        |         |        |
|-----------------------------|--------|---------|--------|
|                             | Min    | 20.00   | 20.00  |
|                             |        | HU - RO | RO -HU |
| 11 - 17<br>February<br>2018 | Median | 20.00   | 30.00  |
|                             | Mode   | 20.00   | 20.00  |
|                             | Mean   | 20.00   | 46.53  |
|                             | SD     | 0.00    | 31.83  |
|                             | Max    | 20.00   | 115.00 |
|                             | Min    | 20.00   | 20.00  |
| 18 - 24<br>February<br>2018 |        | HU - RO | RO -HU |
|                             | Median | 20.00   | 30.00  |
|                             | Mode   | 20.00   | 20.00  |
|                             | Mean   | 20.73   | 43.05  |
|                             | SD     | 2.62    | 30.46  |
|                             | Max    | 30.00   | 110.00 |
| 25 - 03<br>March<br>2018    | Min    | 20.00   | 20.00  |
|                             |        | HU - RO | RO -HU |
|                             | Median | 20.00   | 20.00  |
|                             | Mode   | 20.00   | 20.00  |
|                             | Mean   | 20.46   | 36.15  |
|                             | SD     | 3.72    | 22.27  |
| 04 - 10<br>March<br>2018    | Max    | 50.00   | 100.00 |
|                             | Min    | 20.00   | 20.00  |
|                             |        | HU - RO | RO -HU |
|                             | Median | 20.00   | 40.00  |
|                             | Mode   | 20.00   | 20.00  |
|                             | Mean   | 21.06   | 50.94  |
| 11 - 17<br>March<br>2018    | SD     | 3.79    | 35.21  |
|                             | Max    | 40.00   | 160.00 |
|                             | Min    | 20.00   | 20.00  |
|                             |        | HU - RO | RO -HU |
|                             | Median | 20.00   | 40.00  |
|                             | Mode   | 20.00   | 20.00  |
| 18 - 24<br>March<br>2018    | Mean   | 34.20   | 84.57  |
|                             | SD     | 25.34   | 81.73  |
|                             | Max    | 100.00  | 250.00 |
|                             | Min    | 20.00   | 20.00  |
|                             |        | HU - RO | RO -HU |
|                             | Median | 20.00   | 110.00 |
|                             | Mode   | 20.00   | 20.00  |
|                             | Mean   | 21.69   | 105.92 |

|                            |        |         |        |
|----------------------------|--------|---------|--------|
|                            | Mean   | 20.00   | 20.00  |
|                            | SD     | 0.00    | 0.00   |
|                            | Max    | 20.00   | 20.00  |
|                            | Min    | 20.00   | 20.00  |
|                            |        | HU - RO | RO -HU |
| 07 - 13<br>January<br>2018 | Median | 20.00   | 30.00  |
|                            | Mode   | 20.00   | 20.00  |
|                            | Mean   | 21.31   | 39.51  |
|                            | SD     | 4.27    | 26.80  |
|                            | Max    | 40.00   | 110.00 |
|                            | Min    | 20.00   | 20.00  |
|                            |        | HU - RO | RO -HU |
| 14 - 20<br>January<br>2018 | Median | 20.00   | 30.00  |
|                            | Mode   | 20.00   | 20.00  |
|                            | Mean   | 20.00   | 41.57  |
|                            | SD     | 0.00    | 28.87  |
|                            | Max    | 20.00   | 150.00 |
|                            | Min    | 20.00   | 20.00  |
| 21 - 27<br>January<br>2018 |        | HU - RO | RO -HU |
|                            | Median | 20.00   | 20.00  |
|                            | Mode   | 20.00   | 20.00  |
|                            | Mean   | 20.00   | 41.04  |
|                            | SD     | 0.00    | 29.81  |
|                            | Max    | 20.00   | 110.00 |
|                            | Min    | 20.00   | 20.00  |

|                       |        |         |        |
|-----------------------|--------|---------|--------|
|                       | SD     | 5.07    | 74.06  |
|                       | Max    | 40.00   | 250.00 |
|                       | Min    | 20.00   | 20.00  |
|                       |        | HU - RO | RO -HU |
| 25 - 31 March<br>2018 | Median | 20.00   | 50.00  |
|                       | Mode   | 20.00   | 10.00  |
|                       | Mean   | 26.28   | 59.53  |
|                       | SD     | 18.98   | 51.95  |
|                       | Max    | 100.00  | 200.00 |
|                       | Min    | 20.00   | 10.00  |
|                       |        |         |        |