Benefits related to Intelligent Truck Parking

Part V (D5)

Project Report Intelligent Truck Parking (Smarta Lastbilsparkeringar)

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Executive Summary

The current report is part of the work carried out in the project Intelligent Truck Parking (Smarta Lastbilsparkeringar) with focus on Swedish road freight transport. The report considers benefits related to Intelligent Truck Parking (ITP) from the following perspectives:

Firstly, Benefit Areas (BAs) are identified. Which area of activity can we exactly expect ITP to generate benefits? If there are benefits in ITP as it is widely expected across Europe and USA, then it should be possible to pin such benefit down to specific aspects. Nine such BAs are proposed and discussed. To determine the actual elements generating the benefits, attributes or parameters are suggested in relation to BAs. Such attributes can serve the purpose of Measures of Effectiveness (MoEs) and hence can be used for ex-ante assessments and ex-post assessments, e.g., using Multi-Criteria Decision Analysis (MCDA). In other to compare suggested BAs to understand where focus should be directed, e.g., in developing business models, changes in parameter values (increase, decrease or no change) was translated into nominal data making the problem a MCDA problem, and Dominance-based Rough Set Approach (DRSA) was employed to estimate a weak rank order of BAs.

Secondly, benefits generated from ITP, contribute differently to different classes of actors in society referred to in this report as stakeholders. Employing a similar approach as above (DRSA), benefits in relation to stakeholder groups were also assessed.

Thirdly, we argue that one way to realize such benefits, is to direct the right type of ITP specific services, or ITP core services, to the right area and for the right type of stakeholders. The link between ITP core services and BAs, as well as stakeholders, is suggested and at the end, we evaluate the benefit from the perspective of ITP core services, using specific quantified (but roughly estimated) attribute values and percentage contributions from each ITP core service. Most of the data is drawn from recent studies and project initiative around Sweden and Europe. The Main findings are:

Key benefit areas for ITP are: accidents as a result of fatigue from excessive driving time (B4), parking facility search time (B1), and (balanced) utilization of parking facilities (B5).

Key stakeholders in ITS benefits are drivers, road haulage companies and parking infrastructure owners.

ITP core services generating the most benefits are Parking Location Guidance (PLG), Parking Reservation (PAR).

Accurate digitalization of TPA information is key to validating findings in this study and also to realizing ITP. The key elements in most of the benefits suggested rely on real time information.

Note: part of the material in this report has been published in the 18th World Congress on ITS, 2011, an extended version of which is accepted for publication in the International Journal of ITS Research.
1. Introduction

As it has been estimated that over 44% of journeys within international road freight transport require at least one rest in order to comply with working time directives, also known as driving and rest time regulations (1), parking infrastructure and information about such infrastructure are clearly necessary to help meet the needs and goals of different transport stakeholders, especially professional drivers. Intelligent Truck Parking (ITP) for heavy goods vehicles (HGVs) is a key priority, both in Sweden and Europe at large, with emphasis on the need to provide information and reservation services for safe and secure Truck Parking Areas (TPA). Such information can go a long way to realizing society wide benefits; including a safer and efficient transport environment, which is at the center of regulation 561/2006 connected to driving and rest times for HGVs in Europe. Enforcement of 561/2006 in Sweden is the responsibility of the Swedish police organization where by 75270 driver work days were a target for 2011 (57).

The aim of this report is to identify and analyze important factors related to the benefits of ITP for HGVs, and their effects on different stakeholders in society. Further, the report will provide initial assessment of ITP core services, such as, reservation of TPA, navigation to TPA, etc. This study differs from earlier work in that it focuses on HGVs rather than private cars, and the current work also takes a broader approach that includes multiple benefit areas. The study identifies the stakeholders accruing suggested benefits, and assesses specific ITP core services for different stakeholders.

ITP is expected to contribute to a broad spectrum of general social benefits, including improving critical aspects of safety and network efficiency and management (2). In 2011, Road traffic accidents in the EU Member States claimed some 34,000 lives and leave more than 1.1 million people injured, representing an estimated costs of 140 billion Euros. Of all these, HGVs were involved in 13% of accidents with victims, whereas 2% of such accidents are associated to wrongly parked HGVs (53). Further, it is estimated that 27% of cargo theft occurs in non-secure TPAs. Even though ITP shows a potential to positively influence some transport related challenges facing society today, little is known about the evaluation of benefits of ITP for HGVs – what specific benefits exist, and for which stakeholders, what are the underlying business models, etc?

Initial assessments of ITP in Sweden indicate a possible reduction in the cost of missing and delayed goods, and a reduction in time-based costs for HGVs (12, 41). Potential stakeholder benefits of improved HGV parking facilities have also been addressed in the project LABEL (4). But most studies, evaluating advanced parking management information systems, have focused on private cars in urban areas (8-11, 26) rather than long-distance HGV transport. A number of benefits have been reported by these studies, including load balancing for overcrowded parking areas, reduction in waiting time before parking, reduction in illegal on-street parking, reduction in wandering vehicles, alleviation of traffic congestion, reduction in air pollution, and increased convenience. Benefits have even been reported in the areas of travel times, distance, destination choices, as well as influencing mode choice (8) in transit areas. Previous work has neither focused on different types of ITP benefits for HGVs nor on the end user perspective and mostly with little empirical evidence.
As knowledge on ITP becomes available through various R&D initiatives, (as in 5, 6, 24,) it is becoming evident that ITP stakeholders have different interests (utilization of TPA, reservation, etc,) and hence specific ITP services (ITP core services), such as truck parking reservation, may be required to address the various stakeholder interests (51).

The structure of the remainder of the paper is as follows. Section 2 presents the methodology, Section 3 describes ITP Benefit Areas (BAs), Sections 4 and 5 present the results and discussion related to the theoretical assessment and interviews, respectively, Section 6 presents the conclusions and future work, and Sections 7 and 8 list the acknowledgements and references, respectively.

2. Methodology

The main tool used in the assessments presented in this report is the observation of activities related to HGV TPAs, such as allocation of parking facilities, how information about facilities is delivered to users, and how users locate and access required facilities. Lots of the sources of observations are literature and project reports. Additionally, by observing actors involved in different activities, key stakeholder groups are identified. Assessments of information gathered from observations are carried out, e.g., what are the benefits involved in reducing number of thefts at TPAs, what are possible solutions to reduce number of theft at TPAs?, etc. Multi-criteria Decision Analysis (MCDA) is employed to rank Benefit Areas (BAs) and stakeholder groups. ITP core services are proposed, as part of the solutions, to deal with truck parking related challenges. Thus positive benefits, or contributions of ITP core services, are assessed leading to an assessment of ITP as a whole. Figure 1 illustrate the approach used in the report.

Figure 1: diagram representing the assessments approach employed in this report.
Nine Benefit Areas (BAs), and seven stakeholder groups for ITP, are suggested (see Section 3, Table 1) based on a review of previous research related to ITP (2-4, 12-13), advanced parking management systems (such as 8, 11, 26, 39), project reports (such as 1, 3, 4, 6, 13, 15), and informal and formal discussions. Benefits are typically generated from reducing negative effects, or improving positive effects, that can be observed from changing (increasing or decreasing) attribute values (28).

Decisions concerning the implementation of ITP require an understanding of what benefits are generated and for whom. To facilitate such decisions, the current study chooses to evaluate BAs according to their relative differences based on a given set of attributes (summarized in Table 1). For each attribute and BA, we assign a nominal value indicating the change required to generate a benefit (d = decrease or i = increase) and the authors’ estimation of its effect (bold = high, non-bold = low, • = no effect). For each BA and stakeholder group (see Table 5), we assign a nominal value indicating the authors’ estimation of the non-quantifiable (X) and quantifiable (€) benefits (with the number of symbols indicating the relative difference).

As there are several attributes to consider, with each attribute leading to a different outcome, we model this as a Multi-Criteria Evaluation (MCE) problem. MCE problems have been approached using fuzzy sets, rough sets and optimization-based methods. Extensions of rough set theory such as Dominance-based Rough Set Approach (DRSA) have been proposed for estimating a weak rank order of objects on the basis of multiple criteria (30, 31, 32). Using an open source tool, jRank (33), we employ a DRSA in which, given an initial preference order of BAs, the model returns numerical scores that estimate the variation between BAs. We then use these scores as weights to assess stakeholder benefits across all BAs. The purpose of evaluating the benefit variation among stakeholders is to provide further information that will help decision-makers understand the benefits associated with ITP, creating a path to a successful business model.

In a specific case study recent work related to ITP and freight transport is employed both at the national level (49, 50, 52, 55-59), and at the European level (53, 54) to help quantify specific benefit attributes. Using information gained from the reviews, ITP core services are assessed using a valuation method that was suggested earlier (41).

3. Anticipated benefits in relation to ITP

3.1. ITP Benefit Areas (BAs)

Based on a review of previous research and project reports, we identify several benefits associated with ITP for HGVs. In this study, we choose to categorize these benefits into Benefit Areas (BAs) in order to facilitate analysis of the overall ITP benefit. Later we suggest for each BA, attributes or parameters through which the benefits can be assessed. In some situations a benefit area itself can be seen as a parameter, or benefit attribute, provided such a benefit area can fairly and practically be measured e.g. theft at TPA.

Reducing the time it takes to search for available parking is a benefit. Though the drivers’ search time is unknown, estimates of up to 30 minutes for private cars composing 30% of traffic have been reported for cities such as Stockholm (11). In the case of HGV transport, the problem could be worse due to vehicle size and relatively fewer parking facilities. Currently truck drivers stop earlier than necessary due to risk of not finding a parking space if their driving time is exhausted. In total, non-efficient use of time gets significantly large. Attributes that can facilitate an assessment of this benefit include changes in driving time, distance-based vehicle costs such as depreciation, search traffic (amount of vehicles on road that are looking for a parking space), fuel use, emissions, and Parking Area (PA) occupancy. Some of these benefit attributes (changes in driving time) have been reported in different regions around the world, most for private cars (8, 10, 14).

3.1.2. B2: Parking-related theft and damage.

A reduction in theft, damage or sabotage related to HGVs at TPA will lead to economic savings. Currently, the Swedish National Council for Crime Prevention (BRÅ) reports a steady decrease in the number of vehicle-related crimes over the last decade (15), but most of the reported cases occur in, or are connected to, parking (estimated to be 27% in Europe (53)). Attributes for measuring this benefit include; goods and vehicle thefts, and damages occurring at parking sites, as well as cost of stolen vehicle recovery. The use of surveillance cameras can reduce vehicle-related crimes in parking areas up to 51% (27). Poor lighting is considered a primary cause of theft in parking areas (45). Improved parking security contributes to a better work environment, fewer dangers, and help in informed decision-making for drivers (13).

3.1.3. B3: Accidents as a result of illegal parking.

Among the causes of road accidents are collisions with (or obstructions due to) parked HGVs, and such accidents have increased in Europe as a result of driving time regulations (16). Not parking in areas likely to pose a danger to others, e.g., on the roadside, could undoubtedly reduce some of these accidents. Up to 10% of accidents related to parking could have been avoided if drivers had parked in an appropriately designed parking area (18), (accidents may still occur with parked vehicles when they are properly parked). Benefit attributes include the occurrence of illegal parking, the number of related accidents, and costs of fines. The Swedish Enforcement Authority reports that 45% (or 47.3 million Euros) of unpaid debt cases in 2008 were related to fines for illegal parking for all vehicles (17). ITP can contribute to reducing illegal parking for those cases in which a lack of parking information, or the ability to reserve a parking, negatively influenced the decision of where to park.

3.1.4. B4: Accidents as a result of fatigue from excessive driving time.

Fatigue-related accidents can be reduced with timely parking information that helps to optimize trip planning, in order to ensure that driving time windows are synchronized with parking space availability. Benefit attributes include the occurrence
of driving time regulation violations, as well as the number of related accidents, and costs of fines. Survey studies in Sweden indicate that 38% of drivers and road haulage companies have problems, e.g., complying with driving and rest time regulations, and hence may not fully comply with the regulations (46). Random police controls of HGVs on Swedish roads found that 292 out of 2020 drivers had violated driving and rest time regulations. Recent statistics report far higher percentage violations with only 5% seen have fully complied with the regulation (56). Fatigue-related accidents for HGVs are estimated at 57% (35, 36, 37) globally and 25% of all Swedish road accidents (19). ITP can aid in reducing those accidents for which a lack of parking information is a contributing factor.

3.1.5. B5: Utilization of parking facilities.

Load balancing in the utilization of parking areas can be beneficial. Load balancing refers to a reasonable distribution of HGVs across different TPAs rather than overcrowding (or underuse) at a specific TPA. One aspect of load balancing is the geographic distribution of TPAs. In Sweden, most road segments have less than two hours driving time between TPAs with food services, although many areas become overcrowded during peak hours (49). Advance parking information can help reduce overcrowding, which leads to shoulder damage, restriction of sight, litter, noise, etc (20). Benefits, related to managing overcrowding, are reported in the United States (8, 21). Up to 30% load increase in car parking area utilization is reported in Stockholm as a result of congestion charging (48).


During the time a vehicle is parked, activities, e.g., laundry, vehicle wash, etc, can generate some economic benefits. Rather than parking illegally or in an overcrowded parking area, the efficient utilization of parking areas can improve economic activity involving services and amenities such as maintenance, wash stations, restaurants, etc. Benefit attributes include newly created business involved in the delivery of ITP, load balancing (reduced overcrowding and underuse), services and amenities, etc.

3.1.7. B7: Perceived safety.

Access to information enhances perceived safety by lowering stress and uncertainty for drivers, particularly along unfamiliar routes, or in unfavorable conditions. Benefit attributes include accessibility of parking information and booking services, information about services, amenities, and parking area security.

3.1.8. B8: Potential to support recharging stations for environmentally efficient HGVs.

This is a potential benefit whereby ITP can provide information about important infrastructure, which could facilitate the development and use of more environmentally efficient vehicles such as hybrid HGVs (22). During rest times at suitably equipped areas, vehicles can take advantage of services such as recharging. Since charging duration is an important consideration, ITP information about services and space availability provides a suitable starting point (23).
3.1.9. **B9: Insurance premiums.**

As distance-based insurance schemes for HGVs are being adopted (38), the use of historic data can lead to the benefit of adjusting the insurance cost to match the estimated level of risk exposure (24), which should encourage the use of legal and secure parking in order to get rewards in the form of lower insurance premiums.

Furthermore, indirect benefits may be taken into consideration, although this is out of the scope of this paper. For example, an increase in legal, secure parking will likely lead to fewer incidents, which may improve a road haulage company’s reputation, which may lead to increased revenue through increased contractual work (25). It is important to point out that the anticipated benefits of ITP discussed above are not independent of the types of services that are implemented and used together with ITP, e.g. Navigation and ITP will not lead to the same benefits as Intelligent Speed Adaptation and ITP (12).

### 3.2. Attributes connected to BAs

Table 1 summarizes attributes connected to various benefit areas. Where possible, quantitative estimates (in the case of the Swedish freight transport) are provided in order to understand the level of impact of the issue(s) associated to each attribute. Even though we stated earlier that are parameters that can practically be measured, we have chosen to include some attributes that are hard to estimate at the moment, but that convey knowledge about potential ITP benefit in some way.

The following key assumptions are made in order to estimate the value of the attributes bin Table 1:
- Implementation and deployment of ITP core services is but one out of several ways through which an attribute value can be changed (increased or decreased). Therefore, under a 100% successful implementation, deployment and penetration of ITP, the probability of influence of on a given attribute is limited to a certain maximum. As such, we have suggested probable level of influence on each attribute associated to ITP according to our knowledge about ITP and the attribute in question e.g. 50%, 80% etc.
- In many circumstances we have used the proportionate distribution of vehicle population in Sweden to reflect the severity of an issue in each segment of the vehicle population with HGV accounting for roughly 20% of the total vehicle population in Sweden. This may not always be true because HGVs are not equivalent to personal cars especially regarding several external effects on society. Regardless of this, our intention is to have a rough idea of the severity of some of the attribute related issues.
- Finally, we have made use of some knowledge that is established at European level on certain attributes to have more or less similar interpretation on the Swedish level. This is again an approximation because Sweden shows some extreme differences from the rest of Europe in certain aspects, e.g., accidents statistics for Sweden show very small numbers compared to the rest of Europe.

Based on the above assumption attributes and BAs have been established and estimated as shown in Table 1. In addition, for each attribute, we assess a probable influence given a successful implementation of ITP, i.e., the chances that an attribute value can change,
but also an estimate of the current situation (e.g., the cost), within the Swedish freight transport industry.

<table>
<thead>
<tr>
<th>Benefit Attributes (expected change)</th>
<th>Benefit Area</th>
<th>Cost effect in Sweden (Million SEK)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B1</td>
<td>B2</td>
</tr>
<tr>
<td>Driving time (0.5)</td>
<td>d</td>
<td>•</td>
</tr>
<tr>
<td>Distance-based vehicle cost (0.6)</td>
<td>d</td>
<td>•</td>
</tr>
<tr>
<td>Efficient use of non-driving time (0.6)</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Fuel use due to search (0.6)</td>
<td>d</td>
<td>•</td>
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<tr>
<td>Goods theft at TPA (0.8)</td>
<td>•</td>
<td>d</td>
</tr>
<tr>
<td>Vehicle theft at TPA (0.9)</td>
<td>•</td>
<td>d</td>
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<tr>
<td>Damages (to goods and HGV) at TPA (0.7)</td>
<td>•</td>
<td>d</td>
</tr>
<tr>
<td>Cost to recover stolen HGVs (0.9)</td>
<td>•</td>
<td>d</td>
</tr>
<tr>
<td>Accidents from illegal parking (0.8)</td>
<td>•</td>
<td>•</td>
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<tr>
<td>Fines from illegal parking (0.6)</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Illegal parking (0.7)</td>
<td>•</td>
<td>d</td>
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<tr>
<td>Fatigue-related accidents (0.7)</td>
<td>d</td>
<td>•</td>
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<tr>
<td>Violation of driving regulations (0.8)</td>
<td>•</td>
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<tr>
<td>Cost of driving regulation fines (0.6)</td>
<td>•</td>
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<tr>
<td>TPA occupancy level (0.8)</td>
<td>i</td>
<td>i</td>
</tr>
<tr>
<td>Search traffic on roads (0.7)</td>
<td>d</td>
<td>•</td>
</tr>
<tr>
<td>Load balancing – TPA overcrowding (0.5)</td>
<td>•</td>
<td>d</td>
</tr>
<tr>
<td>Load balancing – TPA underuse (0.9)</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Cleanliness and quality of service at TPA (0.5)</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Companies involved in ITP service provision (0.9)</td>
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<td>•</td>
</tr>
<tr>
<td>Newly created services and amenities at TPA (0.8)</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Back office administration (0.9)</td>
<td>d</td>
<td>•</td>
</tr>
<tr>
<td>Accessibility of information for environmentally efficient HGVs (0.5)</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Accessibility of availability-related information (1)</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Accessibility of amenity-related information (1)</td>
<td>•</td>
<td>i</td>
</tr>
<tr>
<td>Accessibility of security-related information (1)</td>
<td>•</td>
<td>i</td>
</tr>
</tbody>
</table>

Table 1: Attributes in connection to benefit area. Key: i benefit by increase, d benefit by decrease (bold high benefit, non-bold low benefit), • no change.

In the remaining of this section we explain how each of the above estimates have been obtained.

### 3.2.1. Driving time

This is the effective time spent behind the wheel while the HGV is in motion, i.e., effective driving time, excluding non-driving related activities such as fueling, rest time, etc. From our previous study we estimated the total driving time in Sweden based on
data from 2008 to be 41 million hours (41). Considering that ITP core services can improve driving efficiency and unnecessary longer search time, there is a possibility of influencing driving time. We anticipate the chance of experiencing a change in driving time with the implementation of ITP to be 50%. This means upon successful implementation of ITP, there is a 50% chance that the driving time will experience a change. If we assume an average driver cost of 175 SEK an hour (41), an estimated potential of 41M Hrs \(\times 175 \times 0.5 = 3587.50 \approx 3588\) million SEK, can be influenced with the implementation of relevant ITP core services.

3.2.2. Distance-based vehicle cost

When it comes to cost of HGV operations, aspects such as depreciation and potentially road charges and insurance are increasingly seen as distance based functions. Accurate information about the location as well as availability of a parking place in TPA will reduce both the time and (with even a bigger chance) the distance travelled. In our previous study we estimated the cost of driving time to be 5150 million SEK (41). Thus we consider a slightly higher chance (60%) that ITP core service implementation will have an influence on the distance travelled by HGV and hence we estimate this potential to be 5150*0.6 million SEK = 3090 million SEK.

3.2.3. Efficient use of non-driving time

This is the difference between the effective driving time and total traveled time. Activities such as fueling, rest time, maintenance, feeding etc, may sometimes occur in the course of transportation. During such activities HGV drivers may have to take some time off their driving work. With the implementation of ITP core services there exists a window of opportunity to maximize these non-driving but necessary activities and even eliminate some of the stops, e.g. by choosing a parking location with required choice of facilities like fuel station, restaurant, vehicle maintenance etc. ITP core services provide not only the information about TPA and associated facilities but even planning aid to arrive at convenient TPAs. Generally it has been roughly estimated that 30% of total trip time is spent in these non-driving related activities and if we estimate the chance of an impact with ITP core service implementation to be 60%, the potential in relation to such services will be 0.3*41*175*0.6 million SEK = 1291.50 \(\approx\) 1292 million SEK.

3.2.4. Fuel use due to search

Since ITP is expected to have an influence on the search time and distance travelled, by induction there should be an effect on fuel use due to search and even emissions as a result. From previous study we estimate the total cost of fuel used in driving based on 2008 driving statistics in Sweden to be 8320 million SEK [41]. We suppose that 20% of fuel used is due to search (given that 30% of time is used in search) and with an equal chance to reduce fuel as distance we have 0.2*8320*0.6 million SEK = 998.40 \(\approx\) 998 million SEK. This potential include emissions cost, mainly CO\(_2\), which is included in the fuel costs (at least in Sweden).
3.2.5. Goods theft at TPA

Three of four transport companies in Sweden (one in six drivers in Europe according to TRANSPark) have in several occasions experienced theft in parking areas (59). Here we consider only the value of stolen goods in relation to TPAs in Sweden and assume that 27% of theft related to goods occur in parking (53). Previous studies based on police reports estimate the cost of goods theft in Sweden to be 469.70 million SEK mostly in parking areas (43). ITP core services may not entirely eliminate good theft but from the experience of using e.g. CCTV cameras, one can anticipate a huge impact leading us to suggest the ITP potential for influencing this problem could be as high as 80%. Hence a potential of 469.70*0.8*0.27 million SEK = 101.46 ≃ 102 million SEK, in relation to ITP core services can be expected. Table 2 below obtained from a report that studies theft related to HGV in the TAPA EMEA ISS data base (just one of several data bases reporting such data in Europe) showing the various incidents and characteristics over time. As can be seen from Table 2 there is a significant increase when it comes to theft at parking areas and this was some 8 years ago, the situation has only become worse today (27% estimate today). The strange thing is that secured TPAs had more incidents from 2001 to 2003 than the non-secured areas and thereafter the situation was completely different in 2004.

<table>
<thead>
<tr>
<th></th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal</td>
<td>36%</td>
<td>29%</td>
<td>22%</td>
<td>17%</td>
</tr>
<tr>
<td>Parkering</td>
<td>1%</td>
<td>0%</td>
<td>6%</td>
<td>14%</td>
</tr>
<tr>
<td>Kapning</td>
<td>8%</td>
<td>11%</td>
<td>13%</td>
<td>13%</td>
</tr>
<tr>
<td>Förlost under transit</td>
<td>20%</td>
<td>21%</td>
<td>14%</td>
<td>13%</td>
</tr>
<tr>
<td>Stulen lastbil</td>
<td>4%</td>
<td>4%</td>
<td>11%</td>
<td>12%</td>
</tr>
<tr>
<td>Stulet ur öppnad lastbil (jump up)</td>
<td>23%</td>
<td>24%</td>
<td>23%</td>
<td>12%</td>
</tr>
<tr>
<td>Försök till stöld, misslyckades</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
<td>7%</td>
</tr>
<tr>
<td>Bedrägeri</td>
<td>2%</td>
<td>1%</td>
<td>5%</td>
<td>6%</td>
</tr>
<tr>
<td>Flygplats</td>
<td>1%</td>
<td>3%</td>
<td>1%</td>
<td>3%</td>
</tr>
<tr>
<td>Säker parkering</td>
<td>5%</td>
<td>6%</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>Illegal (illegals)</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0.3%</td>
</tr>
<tr>
<td><strong>Totalt antal</strong></td>
<td><strong>118</strong></td>
<td><strong>234</strong></td>
<td><strong>333</strong></td>
<td><strong>344</strong></td>
</tr>
</tbody>
</table>

Table 2, data showing theft incident and characteristics for different years obtained from TAPA EMEA ISS data (source Transek AB report (59))

3.2.6. Vehicle theft at TPA

An estimated 3000 cases of theft related to HGVs were reported in Sweden in 2011 (52) and another study estimate that 27% of these cases are related to or occur at TPAs (53). Back in 2005, Transek AB (59) carried out a study based on police report that estimated a total of 414 HGV thefts (see Table 4) and this number is reported to have increased by 14% (while theft related to personal cars is on the decline). The average
estimate for the cost of vehicle theft in Sweden is about 212000 SEK (compare to 450 000 SEK in EU, half associated to goods) (43). We anticipate a rather high chance of 90% that vehicle theft in connection to TPA can be reduced leading to a potential of 472*212K*0.9*0.27 = 24.32 ≈ 24million SEK. Table 3 shows data about vehicle theft demographics across Sweden in 2004.

Table 3, reported HGV theft in different regions of Sweden, for 2004 (source Transek AB report (59))

3.2.7. Damages (to goods and HGV) at TPA

Sometimes there are damages that occur to goods at TPA for several reasons e.g. exposure to bad weather conditions, accidents, sabotage etc. Such damages can be reduced with the help of ITP core services since the choice of parking will consider the priorities of the goods e.g. level of security. It can be estimated that such a reduction may not supersede the reduction in theft and hence we estimate a chance of 70% to achieve an impact on damages. Goods damage estimates from 2007 indicates a total of 461 million SEK collected in cash by insurance companies while paying a total of 295 million SEK (43) in damages to good owners. The difference (461-295) million SEK = 166 million SEK (with an additional self risk assumed to be 20%) paid by hauler companies implies the total cost of damages in 2007 was 199.20 million SEK. From the perspective of ITP services we estimate the attribute potential to be 0.27*0.7*199.20 million SEK = 37.65 ≈ 38million SEK.
3.2.8. Cost to recover HGVs stolen from TPA

In a previous study an associated incremental cost to theft, connected to HGVs, together with engagement activities of all actors involved from hauler companies to police, insurance and goods owners is estimated at approximately 584.34 million SEK (43). A fraction of this cost, which we estimate as 20%, is connected to recovery of stolen goods or HGV as it is separated from the value of the goods itself. In addition, not all cases are related to TPA and as estimated earlier we will use a 27% fraction for TPAs (53). Implementation of ITP services could be a partial solution in which we estimate a possibility of 90% to influence theft related to parking and hence reduce the cost associated to recovery of stolen HGVs and goods. A rough estimate is 0.27*584.34*0.9*0.2 million SEK = 28.40 ≃ 28 million SEK.

3.2.9. Accidents from illegal parking

Recent studies on the European Truck Accident Causation (ETAC) reveals that human factors account for most of the accidents related to HGVs (85.2%) with 3% percent occurring due to entry or exit from a parking (54). Further, the study estimates that 2% of all truck accidents are related to wrongly parked HGVs while trucks in general are involved in 13% of accidents with victims. The chances of ITP minimizing such accidents do not only depend on appropriate parking of HGVs, but also on human related factors, hence we estimate a probable chance of 80% associated to the implementation of ITP. A reflection of ETAC estimate in the case of Sweden in which an earlier study estimate the total cost of accidents related to HGVs to be 2010 million SEK will translate to a potential of 0.02*2010*0.8 million SEK = 32.16 ≃ 32 million SEK.

3.2.10. Fines from illegal parking (unpaid)

Illegal parking refers to vehicles parked in non-parking designated areas or areas where parking is specifically forbidden e.g. by indicating with a road sign. Reports indicates that the National Swedish Debt Agency (Kronofogden) had registered a total of 473 million SEK in unpaid charges related to illegal parking involving all types of vehicles in Sweden during the year 2009(17). Going by the proportion of HGV population (18% of total traffic) and a potential of 60% associated to the use of ITP core services, a rough potential for this attribute will be 473*0.6*0.18 million SEK =51.08 ≃ 51 million SEK.

3.2.11. Illegal parking

In 2009 the National Swedish Transport Administration (STA) registered 1.3 million cases of illegal parking i.e. involving all engine driven vehicles (50, 55). The total charges collected due to illegal parking in 2009 amounted to 680 million SEK (55). Since illegal parking can partly be a result of lack of proper information about TPA, we suggest that the chance of addressing illegal parking with ITP core services might be about 70%. Generally the amounts of fines levied in Sweden vary between municipalities and can range from 75SEK to 1000 SEK. If we consider a proportionate distribution of fines with
vehicle population (as an approximation), illegal parking in the context of HGVs can be estimated at $680\times 0.7 \times 0.18$ million SEK = 85.68 ≈ 86 million SEK.

### 3.2.12. Fatigue-related accidents

ETAC accident data base study shows that fatigue accounts for 6% of accidents related to truck driving of which 37% are fatal and 90% occur in interurban roads or highways (53). A reflection of these figures for Sweden considering a potential for ITP core services of 70%, an earlier accident estimate of 2010 million SEK, we have $0.7\times 2010 \times 0.6 = 844.2 \approx 844$ million SEK.

### 3.2.13. Violation of driving regulations

Driving and rest time control carried out recently by police in Sweden (in selected areas of the country) shows that about 5% of the cases are without any issue which means 95% of the HGV drivers violate one or more of the driving and rest time regulation (561/2006) (see Table 4) (57). Table 4 shows data related to violations of driving and work time directives in Sweden from 2007 to 2011.

<table>
<thead>
<tr>
<th>Year</th>
<th>Violations</th>
<th>Total reported violations</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>5885</td>
<td>27,672</td>
</tr>
<tr>
<td>2008</td>
<td>2997</td>
<td>37,320</td>
</tr>
<tr>
<td>2009</td>
<td>7249</td>
<td>23,540</td>
</tr>
<tr>
<td>2010</td>
<td>22,276</td>
<td>56,887</td>
</tr>
<tr>
<td>2011</td>
<td>21,965</td>
<td>37,987</td>
</tr>
</tbody>
</table>

Table 4 showing data related to violations of driving and rest time in Sweden from 2007 to 2011 (source Swedish police report (57)).

Other surveys indicate a rather small number, 14.5%, of drivers that violate driving and rest time regulations (46, 47) although the variation is largely due to the sample considered. The estimated fine per violation varies between 3000 SEK (tachograph is fault free) to 6000 (include lack of or damaged tachograph). If we consider an average of 4500 SEK for all violations in 2011, and associate ITP to 80% of the chances to resolve driving time regulation violations, then we get a potential estimate of $4500\times 37987 \times 0.8$ SEK = 119.66 ≈ 120 million SEK.

### 3.2.14. Cost of driving regulation fines

The preceding attribute estimate how much costs generated due to number of violations. It has been shown that foreign HGVs cash in an estimated 110000 SEK each year in driving regulation fines. Since foreign traffic constitute only 2% of total HGV fleet in Sweden, an extrapolation of the estimate shows the total cash from driving violations could be $50\times 110000 \times 0.6$ SEK = 3.30 ≈ 3 million SEK each year.
3.2.15. TPA occupancy level (0.8)

Total estimated income from parking in 2010 was 980 million SEK (50). Stockholm alone accounted for more than 80% of total income generated from parking. Supposed this income is proportionate to the vehicle population distribution i.e. 18% of HGVs accounted for a fair share and the chances of changing the use TPA can be expected to be as high as 80%, then we have $0.18 \times 980 \times 0.8 = 141.12 \approx 141$ million SEK.

3.2.16. Search traffic on roads

The fraction of vehicles on road in search of a truck parking spot generates congestion. At first sight this may seem rather small even though it is estimated that such traffic may account for 30% of total traffic in urban areas like Stockholm. In 2009 the National Swedish Transport administration garnered 770.6 million SEK in the form of congestion charges (trängselskatt)(55). A representative share for HGVs will be $770.6 \times 0.5 \times 0.18$ million SEK $= 69.35 \approx 69$ million SEK, assuming a 50% effect associated to ITP.

3.2.17. Back office administration

Enforcement of regulation 561/2006 in Sweden is the responsibility of the Swedish police organization where by 75270 driver work days were a target for 2011 (57). This task is shared with the Swedish transport administration (Transportstyrelsen) which is responsible for control at the level of the transport organizations (back office). In their yearly report from 2011, the Swedish Transport administration indicates a staggering 14% (or 28 million SEK) increase in their annual running budget of 345 million SEK (58). The increase was mostly associated to the engagement on driving and rest time regulations that was taken over from police from January 2011 (only at the level of the hauler company organization). With only a few companies chosen for control (based on risk assessment), it can be estimated the cost of driving and rest

For the rest of the attributes shown in Table we couldn't find sources of information that could lead us to estimate the current situation in Sweden but with time as more information and approaches are being developed it could be possible to estimate such attributes.

3.3. The stakeholders

Different segments of society when viewed from an ITP perspective play different roles in connection to HGV parking and hence ITP. For instance drivers aim at using TPAs when and where needed, service providers see it as a business opportunity etc. Table 5 summaries our view on the connection between ITP stakeholders and the benefit areas suggested above.
Table 5: Stakeholder in connection to each benefit area. Key: € quantifiable benefit (increases with number of €), X non-quantifiable benefit, • no change.

Specifically, the stakeholders are used in the following contexts:

- Transport Telematic Service Provider (TSP): Telematic service providers that can potentially deliver ITP related services or other transport telematic services
- Drivers: Professional HGV drivers.
- Road haulage companies: could be fleet owners or authorized departments in charge of HGV fleets e.g. fleet managers.
- Goods Owners: Product owners who hire a transport service.
- Parking infrastructure owners/operators: These are organizations or individuals who own and/or operate parking facilities.
- Road users: these are other road users beside HGV drivers, e.g. private car drivers.
- Traffic controllers: these are individuals or organizations, e.g. police who manage the road network traffic. They are expected to provide solutions, e.g. about alternative road when there is an accident.

We exclude two other parties that may be of interest to some other researchers i.e. Government/municipalities (legislators, national road agents etc) and HGV manufacturers. We exclude these stakeholders since we are looking at ITP from a benefit perspective and we anticipate that their stakes with respect to ITP benefits might not be significant. For governments, it is important, at least theoretically, that under a healthy business environment, ITP should generate benefits for someone in society; hence the government can be seen to play the role of a regulator. HGV manufacturers will potentially indirectly benefit from a successful deployment of ITP e.g. increased safety through accessible information on parking choices. Beyond indirect benefits it is unclear at the moment if HGV manufactures are willing to directly engage in development, deployment and operation of ITP in the face of challenges such as varying technologies across different manufacturers etc.

3.4. ITP core services

In order to generate the different benefits identified for different areas and stakeholders, a service provider can direct specific services to targeted BAs. For a user or actor involved in aspects related to HGV parking e.g. transport planner, available ITP services maybe employed to address various needs, for instance, searching and locating...
a parking, will generate the benefit of time saving (B1). Following this line of reasoning it is possible to:

- Identify subservices (ITP core services) targeting specific benefit areas (51).
- Analyze if such services can be competitive by connecting them to users and assessing potential impacts.
- Quantify the benefits of each of the services for a specific target users or user group.
- Validate the quantified benefits e.g. through interviews.

We anticipate a number of core services and connected areas generating the benefit for the service by an “x” as shown on Table 6. Further the connection between identified core services and stakeholders is indicated with an x in Table 6. The reason we choose to relate ITP core services with BAs instead of benefit attributes is to enable us identify which are the benefit.

<table>
<thead>
<tr>
<th>Benefit Area &amp; Stakeholders</th>
<th>ITP core services</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TPU</td>
</tr>
<tr>
<td>BA1</td>
<td>x</td>
</tr>
<tr>
<td>BA2</td>
<td></td>
</tr>
<tr>
<td>BA3</td>
<td>x</td>
</tr>
<tr>
<td>BA4</td>
<td></td>
</tr>
<tr>
<td>BA5</td>
<td>x</td>
</tr>
<tr>
<td>BA6</td>
<td>x</td>
</tr>
<tr>
<td>BA7</td>
<td></td>
</tr>
<tr>
<td>BA8</td>
<td>x</td>
</tr>
<tr>
<td>BA9</td>
<td>x</td>
</tr>
<tr>
<td>Traffic controllers</td>
<td></td>
</tr>
<tr>
<td>Road users</td>
<td></td>
</tr>
<tr>
<td>Telematic service providers</td>
<td></td>
</tr>
<tr>
<td>Goods owners</td>
<td>x</td>
</tr>
<tr>
<td>Parking infrastructure owners</td>
<td>x</td>
</tr>
<tr>
<td>Road haulage companies</td>
<td>x</td>
</tr>
<tr>
<td>Drivers</td>
<td>x</td>
</tr>
</tbody>
</table>

Table 6, indicating core services and connection with benefit areas as well as stakeholders (Truck Parking facility Utilization (TPU), Goods and Vehicle Safety assurance information (GVS), Parking Location Guidance (PLG), Parking Reservation (PAR))
4. Benefit Assessments

Given the data above related to the estimation of attribute values, the stakeholders and BAs considered, the following sections make an attempt to carry out different types of assessments:

4.1. A theoretical assessment of ITP stakeholders connected to BAs.

A number of assumptions are necessary to perform the theoretical analysis:

- The total ITP benefit is composed of domains of benefits (BAs) with each consisting of several specific attributes that, in combination, can be used to assess the BA e.g. parking search time can be assessed with attributes such as driving time, distance-based cost, etc;
- For each benefit attribute, we can determine the change required to generate benefits, e.g. a decrease in driving time, an increase in parking area occupancy level, etc;
- Since the change in attributes cannot only be linked to ITP but also to other activities (i.e., ITP is only a partial solution), we can hypothetically estimate the change due to ITP (given in parentheses in Table 1, first column), e.g. driving time is affected by many factors, but we believe that there is a 50% chance of ITP affecting driving time as accessible parking information will enable efficient planning;
- ITP has different affects on different actors in society. In the case of benefits, key stakeholders groups can be identified.
- Finally, we assume there is perfect information flow between ITP systems and from ITP to stakeholders, e.g. insurance schemes for drivers, goods or vehicles calculated on the basis of exposure to risk have access to all information including parking locations, security, etc.

There are several ways to conduct assessments in order to obtain the information needed to create Table 1, which summarizes our perceptions of benefit attributes for each benefit area and, where possible quantified estimates of the current situation in Sweden. For a study of absolute benefits associated with different BAs and their attributes, it is necessary to carry out field operational tests (to enable ex-post assessments) in which the performance of ITP in the different BAs can be measured via the different attributes (39). Due to practical limitations, such field test data is not available, especially as ITP is still at an infant stage. An alternative approach is to study relative differences between benefit areas that can be used as a reference for decision-making across a variety of regions and cases. To study such relative differences, it is enough to have information that can help show the differences between BA for a given
attribute e.g. using numerical weights. To achieve this, we use a weight of 1 for d, i, and €, 0.5 for d, i, and X, and 0 for •. In the case of d, i we have multiplied by the estimated change in attribute as a result of ITP (given in parentheses in Table 1, first column).

For each attribute (row in Table 1), a crisp order or rank of BAs can be obtained. However, each attribute will lead to a different crisp order according to the criteria used. To obtain an overall but weak rank using all attributes, DRSA is applied using the numerical weights proposed above. The reason for ranking BAs is to enable the possibility to compare BAs and identify areas of focus that will generate such benefits. Such knowledge is useful in developing the choice of business models for ITP.

![Relative differences based on attributes](image1)

**Figure 2**: Relative differences between BAs on the basis of attribute aggregation with DSRA

![Relative differences weighted by benefit areas](image2)

**Figure 3**: Relative differences between stakeholders' benefits on the basis of weighted BAs

The results (Figure 2) show that B1 is as good as B4 and B2 is as good as B5 while B3 is as good as B6. The most influential areas for ITP are B1 (parking search time) and B4 (fatigue-related accidents) and the least is B7 (perceived safety).

Applying the results obtained from the weak rank in Figure 2 as weights for each of the benefit areas, the total benefit across all areas is assessed for each stakeholder group. The results, plotted in Figure 3, indicate that the drivers will be the leading beneficiaries of the ITP service, closely followed by road haulage companies.
Since the results of the comparison depend much on the nominal scores of the attribute areas, etc, such results need to be interpreted with care. However, we believe that the results of the comparison are early indications of some of the ITP benefits and their respective beneficiaries. One way to complement such an approach is to ask the end users themselves about their perspectives on the ITP service. Do the drivers and road haulage companies see themselves as benefitting from the ITP service?

4.2. A theoretical assessment of ITP Core services connected to BAs.

In the above section an increase or a decrease of attribute values was treated on the basis of equal contributions in order to determine the relative differences between BAs and also among stakeholders. In this section we further determine much specific quantities (with a caution as these are estimates and approximations) in relation to benefits taking the perspective of ITP core services.

In a previous report (51), a number of concepts for ITP core services are anticipated. Even though the suggested services were based on identifying important information flow surrounding ITP, the current section will be focused on relating these ITP core services to BAs through benefit attributes. A study analyzing the evaluation of freight telematic services including ITP have been carried out (41). In the study (41) ITP was seen to reduce time based cost by 0.1% and missing and delayed goods by 1% leading to a potential value of 32.2 million SEK. The difference in the approach adopted here is that ITP is considered to consist of specific core services and hence targeted to specific BAs. This provides more information that will hopefully lead to a better assessment of the potential of ITP. Valuating the benefit of services such as ITP eventually trickles down to valuating information, the change of behavior of information recipient and the eventual effect on society. Table 7 is a synthesis of some of the changes experienced by providing users with directional static information to locate parking areas in cities (61). Even though this mostly applies to private cars it shows the potential of change of attitude (in this case search time and occupancy of parking areas) as a result of providing basic directional capabilities to user.

<table>
<thead>
<tr>
<th>Location</th>
<th>Occupancy</th>
<th>Search traffic</th>
<th>Introduced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helsingborg, Sweden</td>
<td>63%</td>
<td>76%</td>
<td>2005</td>
</tr>
<tr>
<td>Lund, Sweden</td>
<td>10%</td>
<td>10% decrease</td>
<td>1999</td>
</tr>
<tr>
<td>Malmö, Sweden</td>
<td>80%</td>
<td>...</td>
<td>1993</td>
</tr>
<tr>
<td>Stockholm, Sweden</td>
<td>20%</td>
<td>...</td>
<td>2000</td>
</tr>
<tr>
<td>Aalborg, Denmark</td>
<td>47%</td>
<td>12% decrease</td>
<td>1996</td>
</tr>
<tr>
<td>Torbay, England</td>
<td>20%</td>
<td>...</td>
<td>1979</td>
</tr>
<tr>
<td>Aachen, Germany</td>
<td>50%</td>
<td>3.4%</td>
<td>1971</td>
</tr>
<tr>
<td>Japan (Toyota)</td>
<td>71%</td>
<td>...</td>
<td>1982</td>
</tr>
</tbody>
</table>

Table 7, documented change in occupancy and search time in cities due to directional information about parking (synthesized from (61)).

Following relevant examples related to parking and based estimated attribute values an attempt is made to quantify the benefits associated to ITP core services including:

- Parking Facility Utilization (PFU)
- Goods and Vehicle Safety Assurance information (GVS)
- Parking Location Guidance (PLG)
- Parking Reservation (PAR)

The benefit for each ITP core service is generated as a sum of the contribution from different benefit attributes. These contributions include our perceptions as well as the information we gathered from multiple studies and suggestions related to how ITP can contribute to some of the challenges facing TPAs. Unlike in the previous work (41), the results presented Figure 4 have not been treated for dependencies.

Figure 4, results of assessments of ITP core services based on estimated benefit attributes.
5. Concluding remarks and recommendations

The aim of this report is to identify and analyze important factors related to the benefits of ITP (and ITP core services) for HGVs and their effects on different stakeholders in society.

Potential ITP benefits have been deconstructed into Benefit Areas (BAs), benefit attributes, and stakeholder groups. Such attributes can serve the purpose of Measures of Effectiveness (MoEs) and hence can be used for ex-ante assessments and ex-post assessments e.g. using Multi-Criteria Decision Analysis (MCDA). In order to compare suggested BAs to understand where focus should be directed, changes in parameter values (increase, decrease or no change) was translated into nominal data making the problem a MCDA problem and Dominance-based Rough Set Approach (DRSA) was employed to estimate a weak rank order of BAs. Key findings of this report are:

Following from the findings of this report, key areas of benefit in connection to Intelligent Truck Parking from the perspective of the Swedish road freight transport can be ranked in order of increasing merits as:

- Perceived safety (B7)
- Potential to support re-charging stations (B8)
- Potentially lower insurance premiums (B9)
- Accidents as a result of roadside parking (B3)
- Increased economic activity (B6)
- Parking-related theft and insecurity (B2)
- Utilization of parking facilities (B5)
- Parking facility search time (B1)
- Accidents as a result of fatigue from excessive driving time (B4)

Based on this report, if it is possible to also consider different stakeholder groups and find out which actors are most important, from the perspective of benefits. The recommendations from this ranks stakeholder groups in order of increasing merit as:

- Traffic controllers
- Road users
- Telematic service providers
- Goods owners
- Parking infrastructure owners
- Road haulage companies
- Drivers

In order to transform ITP benefits to reality, the right type of services have to reach the right type of stakeholders. Expected contributions from different ITP core services compared to each other show the following ranking in order of increasing merit:

- Goods and Vehicle Safety assurance information (GVS),
- Truck Parking facility Utilization (TPU),
- Parking Reservation (PAR)
- Parking Location Guidance (PLG)
The single most contributing benefit area to ITP in Sweden could be in reducing accidents as a result of fatigue from excessive driving time (B4), and the most contributing ITP core service to realizing this benefit could be Parking Location Guidance (PLG) and the most benefiting stakeholder group could be HGV drivers.

The foundations to the conclusions arrived at in this report are theoretical mainly because information about ITP is still rather scanty out there. These results can be validated and further understanding can be reached if:

- Accurate digital information (e.g. dedicated database) should be established about the inventory of TPAs as well as the inventory for each TPA in terms of number of parking places in Sweden. A cheap alternative will be to upgrade existing databases that already show parking areas in Sweden with a clear distinction between TPAs and privatee parking areas, including available facilities. Unless information about such inventory is readily available it will be difficult to establish an accurate measurement, e.g., of occupancy level or demand etc, all of which provide a cornerstone for ITP benefits.

- Information sharing is required among ITP stakeholders. This will enable a joint coordination toward development, deployment and operation of ITP, since each stakeholder through sharing of information, can be able to understand their stakes in ITP.

In a similar project (7), interviews have been carried out investigating the drivers’ and road Haulage Company representatives’ attitudes towards ITS services including a scenario about ITP. The results indicate that ITP will contribute towards the drivers’ perceived safety and not invade their privacy. The benefit for the company based on the interviews is perceived as slightly positive and marginally higher than the benefit to the drivers, which is perceived as neutral. Based on the company representatives’ estimates of the worth of the ITP service, the annual revenue is approximated at 1.95 million Euros. Following the assessments carried out in this report, the four ITP core services identified can generate up to 26.43 million Euros in a year, far more than the estimated willingness to pay as established from the interview study. This means stakeholders that are leading the deployment of ITP will have to do more to convince potential ITP users. The most selling points to achieve this will be to reach out information related to potential saving areas backed with well established facts supported by quality research.

On one hand our analysis shows that most ITP benefits will be generated through the capability of accurately measuring and processing information in real time e.g. occupancy, reservation, route guidance etc. On the other hand, considering the current state of information availability regarding truck parking in Sweden, a successful approach to the deployment of ITP in Sweden, could require first to gather and share static data about the current inventory on parking areas and associated facilities more importantly to strategically balance inventory and demand. These preliminary steps are pre-requisite for achieving the benefits of ITP.
6. Acknowledgement

We wish to thank ITS Sweden and the National ITS Postgraduate School, Vinnova (Swedish Governmental Agency for Innovation Systems), and Trafikverket (Swedish Transportation Administration) for funding this research.

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