Pay as You Speed, ISA with incentives for not speeding: A case of test driver recruitment

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ABSTRACT

The Intelligent Speed Adaptation (ISA) project we describe in this article is based on Pay as You Drive principles. These principles assume that the ISA equipment informs a driver of the speed limit, warns the driver when speeding and calculates penalty points. Each penalty point entails the reduction of a 30% discount on the driver's car insurance premium, which therefore produced the name, Pay as You Speed. The ISA equipment consists of a GPS-based On Board Unit with a mobile phone connection to a web server. The project was planned for a three-year test period with 300 young car drivers, but it never succeeded in recruiting that number of drivers. After several design changes, the project eventually went forward with 153 test drivers of all ages. This number represents approximately one thousandth of all car owners in the proving ground of North Jutland in Denmark. Furthermore the project was terminated before its scheduled closing date. This article describes the project with an emphasis on recruitment efforts and the project's progress. We include a discussion of possible explanations for the failure to recruit volunteers for the project and reflect upon the general barriers to using ISA with ordinary drivers.

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1. Introduction

1.1. Intelligent Speed Adaptation

Recent developments in Intelligent Transport Systems (ITS) have demonstrated that Advanced Driver Assistance Systems (ADAS) may play an important role in future improvements in traffic safety. Over the past two decades, several studies have conducted tests of a specific type of ADAS, Intelligent Speed Adaptation (ISA). These studies have demonstrated the great safety potential of ISA. The estimated net effect of a full ISA implementation is a reduction of up to 50% in the number of road traffic accidents resulting in fatalities or injuries (Carsten and Tate, 2005; Marchau et al., 2005; Regan et al., 2006; Vlassenroot et al., 2007). Moreover, some scholars also have suggested that ISA may reduce fuel consumption and thereby, automobile pollution (Servin et al., 2006).

ISA is not a specific technology. It belongs to a group of ADAS technologies best suited for keeping track of the speed and position of a vehicle travelling on a segment of road. By comparing these registrations with the speed limit on various road segments, ISA can inform a driver of the relevant speed limit by means of a display in the car. ISA can also alert the driver if the car's speed exceeds the current speed limit. The speed alert function may assume different forms. The most common form is a visual display combined with an acoustic warning. Researchers have also tested resistance in the accelerator that prohibits the driver from increasing speed (Almquist, 2006).

1.2. A short history of ISA studies

The Department of Traffic Technology at the University of Lund in Sweden conducted the first ISA field study in 1992. The study included 75 test drivers, a test car with an active accelerator pedal and a fixed test route. It importantly demonstrated that test drivers held more positive attitudes towards the equipment after the test drive (Persson et al., 1993). This study was followed by a number of ISA projects in several different countries. In Sweden, larger field trials were conducted between 1999 and 2001. These Swedish field trials tested different types of ISA equipment and included approximately 5000 drivers (Warner, 2006; Hälmådahl, 2004; Várhelyi et al., 2004). Studies have also been conducted in the UK, the Netherlands, Belgium, France, Australia and Finland (Jamson et al., 2006; Regan et al., 2006; Peltola et al., 2004). The first Danish field study was completed in 2001. In this “INFATI” project (INFATI is an abbreviation for the projects Danish name: Intelligent FARTIl-passing), the system continually presented the speed limit on a console-mounted display in the car and warned the driver by a...
voice message when speeding occurred. The project included 24 test drivers over a six-week period. The results found were convincing. Driving speed, measured at the 85th percentile, decreased by 5–6 km/h. In contrast to many other ISA experiments, INFATI also covered speed limits in rural areas, and thereby demonstrating that speed reductions obtained by using this equipment were significant on rural roads (which in Denmark generally have an 80 km/h speed limit). Furthermore, the use of a voice message for speed warnings proved efficient and was greatly appreciated by the test subjects (Boroch, 2002; Lahrmann et al., 2001, 2004). As of this time, ISA projects have been conducted in several countries with positive results regarding both the speed-reducing effects of ISA and the test drivers’ acceptance of ISA equipment. The Swedish studies reported that test drivers thought themselves better drivers with ISA, and two out of three test drivers stated they would keep the system in their car after the test period if the system were free. Moreover, one out of three test drivers were willing to pay a small amount for ISA (Bidding and Lind, 2002).

Economic incentives have been absent in most previous ISA trials. In some studies, participants had an ISA-equipped car at their disposal during the test period, which could be considered a reward for participation (Jamson et al., 2006). Only in the Dutch Belonitor project and a minor Swedish project were participants rewarded for not exceeding the speed limit (Belonitor, 2009; Hultkrantz and Lindberg, 2009).

Many ISA projects make the fundamental assumption that motorists intend to comply with the legal speed limit. Speeding occurs either when drivers fail to notice all speed signposts or when they are inattentive to their own speed. Test drivers state that they are pleased to have ISA. Despite these findings, which have been accumulated through two decades of ISA research, there has been no breakthrough of ISA in road traffic. Indeed, the risk of speeding in a modern, quiet and comfortable car is obvious. The general purpose of ISA, therefore, is to support drivers in maintaining the proper speed under the implicit assumption that a driver, if provided with sufficient information, will not exceed the speed limit. In fact, this hypothesis has strong support from the results of previous ISA studies conducted in ordinary road traffic. But why is it that ISA equipment has not been widely introduced? Why have private investors not rushed into this lucrative market, which includes more than 200 million cars in the EU alone? Have researchers focused too much on the positive outcomes obtained and too little on the general acceptance of ISA? Obviously, there has been no voluntary introduction of ISA. Perhaps such an introduction suffers from the well-known obstacle that “those who want it do not need it, and those who need it do not want it” (Jamson, 2006).

2. An ISA project based on Pay As You Speed principles

2.1. Project design

On the basis of these two decades of ISA experience, the present ISA project focused on simulating a market introduction of ISA equipment. The project targeted “those who need it” by addressing car owners aged 18–24 as participants. Car owners in that age group were offered a financial reward for their participation in the project, called Pay as You Speed (PAYS). In short, the Pay as You Speed principle establishes a connection between financial reward for participation and the recorded behavior of the vehicle in terms of speed.

The target group included a large number of inexperienced drivers who are over-represented in traffic accident statistics. In fact, the risk pertaining to that particular age group is up to 10 times greater than that of their parents’ generation (Brems and Munch, 2008). Due to their increased accident risk, inexpe-

Fig. 1. The ISA display mounted on the dashboard.
map (“map matching”) and shows the current speed limit on the display. It also compares the speed limit with the actual speed of the vehicle, and if the vehicle exceeds the speed limit by more than 5 km/h, the OBU emits an initial verbal warning, for example “50”. The warning is repeated every 6 s until the car’s speed drops below the speed limit +5 km/h. The tolerance of 5 km/h allows the participants to drive at speeds slightly above a given speed limit without receiving warnings. This tolerance is supported by the fining practices of law enforcement officials (Copenhagen Police, 2010). After the second warning, the system will add the sentence “you are driving too fast” to the spoken speed limit and will calculate and display “penalty points” every 6 s. The number of penalty points per warning is related to the level of excessive speeding, as shown in Table 1. If the speed is above the speed limit +5 km/h and below the speed limit +20%, the system will impose 1 penalty point every 6 s. In the interval between the speed limit +20% and the speed limit +30%, the system will impose 2 penalty points every 6 s, and so on. When the car’s speed drops below the speed limit +5 km/h, the warnings cease. This sequence occurs any time the vehicle exceeds the speed limit.

For every map-matched position, the system also calculates a map-matching quality. If the parameter-controlled estimate indicates that the map-matching quality is too low, the best guess at a speed limit is shown in brackets on the display, and the system does not react to speeding. A high-performance map-matching algorithm has been developed for the project (Tradisauskas et al., 2009).

When speeding is registered during a trip, the OBU uploads a log file to the web server immediately after the conclusion of the trip. After a trip, it is possible for the driver to log on to a personal web page and check where and why penalty points were imposed (see Fig. 3 for an example). The purpose of the web page is to allow drivers to check, and possibly correct, the record. Originally, the plan was to make it possible to upload map updates to the OBU; however, this feature failed to work satisfactorily. This situation implies that the speed limit map and the actual speed limits were changing during the course of the project. In the context of the present project and based on the number of complaints received, our judgment is that the consequences of this situation were limited. Finally, the OBU had a tracking function. If a car was stolen, the owner could call a hotline, which would send an SMS to the OBU, and the OBU would return the position of the car.

The digital speed limit map covers every road in the county of North Jutland. In the rest of Denmark, only roads with a speed limit of 90 km/h or higher are covered. Outside these roads, the OBU was set to react if a driver exceeded the general 80 km/h speed limit on rural roads. Thus, the speed map covered all the roads in Denmark except for those in urban areas outside North Jutland. Because speed limit data are not available for other countries, the system showed a blank display and did not react to speeding outside of Denmark’s borders (Sonne, 2005; Juhl et al., 2007).

### 3. The field trial

#### 3.1. Recruitment of participants for the field trial

We established the conditions for the field trial in co-operation with a single insurance company, Topdanmark. According to Topdanmark’s price list, the premium for an all-risk car insurance for a young car owner with a typical car is approximately €2400 per year. Prior to setting the conditions for participation in the PAYS project, Topdanmark conducted a market study among their own customers in the target group to assess interest in the project and to identify possible obstacles to participation. The overall results of the study indicated that approximately 16% of the customers in the target group would be very interested and 50% might be interested in participating in the PAYS project. The study also established that both the participant fee and the fact that speeding would be recorded were deciding factors for non-participation (Topdanmark, n.d.).

Following the market survey, we decided to offer participants a discount of up to 30% on their car insurance premiums as a participation bonus. The bonus would be paid in arrears every 6 months, and the participants would have €0.07 deducted from that bonus for each registered penalty point during that period (see the previous description of the penalty points system). In response to limited funding for the project and to bring the project closer to simulating market conditions (and despite the results of the market study), we decided that the participants would initially pay a participant fee of €700, corresponding to the potential monetary gain from the first year of participation, provided the participant did not speed. The participants were offered an interest-free loan at the local bank, and they were guaranteed to receive, at a minimum, the fee as a bonus, regardless of their speeding behavior, if they remained with the project for the full three-year period. The final condition for participation was to purchase car insurance from the co-operating insurance company, Topdanmark.

These conditions were applied when recruitment started in September 2005. A recruitment letter was sent to 6000 young car owners between 18 and 24 years of age in North Jutland. A web page was opened where participants could obtain further information about the project and express their interest in participating in the test trial. The start of the recruiting drive received substantial media coverage. The result, however, was highly disappointing. Only 40 young car owners expressed their interest.

A more comprehensive market study, including the entire target group in the county rather than Topdanmark customers alone, was conducted in November 2005. Again, the target group viewed the project favorably, as a total of 91% thought well or very well of the project. Again, the main argument against participation was the fee and, to a minor degree, the fact that speeding would be

### Table 1

The relationship between speeding and the number of penalty points calculated per 6-s interval of excessive speed.

| X ≥ (H + 5 km/h) | awards 0 penalty points | H = Speed limit |
| (H + 5 km/h) < X ≤ (H + 20%) | awards 1 penalty point | X = Current speed |
| (H + 20%) < X ≤ (H + 30%) | awards 2 penalty points | S = Speeding in percentage |
| (H + 30%) < X ≤ (H + 40%) | awards 3 penalty points |
| (H + 40%) < X ≤ (H + 50%) | awards 4 penalty points |
| (H + 50%) < X ≤ (H + 60%) | awards 5 penalty points |

Etc.
recorded. This study revealed, in addition, that members of the target group were paying much less than €2400 for their car insurance. In fact, approximately 50% of car owners in the group did not have an all-risk but only third-party insurance. Moreover, many customers did not pay the full price for their car insurance because insurance companies offer several discount options. We estimated that, with the insurance rate of the target group averaging €1200, it would take not one, but two years of bonuses to acquire a sum equal to the participation fee. Another obstacle to participation was that participants insured by other companies would have to switch to Topdanmark to participate. The result was that few in either the broader target group or the target group among the customers of Topdanmark signed up to participate in the PAYS project. The conclusion was that PAYS would have been a good project if it had not been for the participant fee (Markman Customer Management, n.d.).

Due to the results of this market study, we were successful in obtaining additional funding to cover the participant fee, which could then be dropped. A new round of recruitment offering free participation started in February 2006. The age limit for participation was also raised to 28 years. Letters were sent to a total of 11,400 car owners in North Jutland County; the result was that 180 persons expressed their interest on the project’s website.

In May 2006, Topdanmark phoned 1000 of their customers to recruit more participants, but this effort yielded only a few more participants.

To confirm their involvement, participants were required to sign a contract with the project. During the summer of 2006, we sent a total of 230 contracts to the car owners who had expressed interest via the web site. The result was 50 signed contracts. The remaining 180 drivers had changed their minds and no longer wished to participate in the project. We did not perform a systematic dropout analysis, but phone calls to 19 of the dropouts strongly suggested that they ultimately did not want to give up their freedom to drive faster than the speed limit (Agerholm, n.d.). Out of the 11,400 persons in the general target group, we were successful in signing contracts with 50 for a 0.5% participation rate. As for Topdanmark customers, 3% of the target group decided to participate.

The goal of the PAYS project was to involve 300 young car owners. After much time and effort, and with only 50 contracts signed,
we abandoned that goal. Instead, we decided once again to change the conditions for participation. In the next recruitment round in September 2006, the age limit for participation was completely lifted, making the target group all motorists in the county of North Jutland. We marketed the project through newspaper advertisements and general press coverage. This round yielded another 30 interested car drivers.

During the spring of 2007, 1500 Topdanmark customers were contacted by phone, which yielded a few more signed contracts. Approximately 125 signed contracts were in hand by the summer of 2007.

The last recruitment round was conducted during the autumn of 2007. A recruitment letter was sent to 2000 Topdanmark customers and a recruitment e-mail was sent to approximately 2500 employees of Aalborg University. We ended the recruitment drive in December 2007 with a total of 153 signed contracts, equal to one in a thousand car owners in the county of North Jutland.

3.2. Early termination of the PAYS field trial

We did not reach the goal of 300 participants, but the field trial proceeded with the 153 participants. We installed the equipment in cars starting with a test group in the summer of 2006. The first ordinary participants had the equipment mounted during the autumn of 2006, and the last group had the equipment installed at the end of December 2007. Over such a long period of time, some participants dropped out for various reasons, and by the end of 2008, only 105 systems were in operation. The original rationale for a large study involving 300 young car owners in a field trial for a period of three years was to obtain sufficient data to enable an analysis of the safety-related effects of ISA by examining the number of traffic accidents among the participants. With only 153 participants, however, the project would probably not generate statistically conclusive results on the safety-related effects of ISA. As with the other ISA projects, we would be able to estimate the safety-related effects of the equipment from changes observed in drivers speed behavior. But it was not necessary to require participants to drive with the equipment for three years to obtain sufficient speed data to describe changes in speed behavior. Therefore, in the autumn of 2008, we decided to stop the project before the scheduled end. Instead of allowing all participants to drive for three years, we decided to turn off the website and the displays of the 105 remaining participants on November 1, 2008. The next 45 days were then used as an after period during which no warnings or penalty points were awarded, but speeding was still logged. We uninstalled the OBU units in January and February of 2009, and on March 1, 2009, the field trial was closed, and data processing began.

3.3. Local politicians as ambassadors

In the midst of the recruiting process described above, we decided to involve local politicians in the project. We wanted them to be ambassadors in their municipalities and advocate participation in the project. We also wanted to discover whether local politicians could be relied upon to play an important role in implementing ISA in general. Are local politicians aware of the new technical possibilities ISA represents? Do they see ISA as a realistic option, ready for implementation? As with other people, politicians form opinions under the influence of personal experience. Without having driven with ISA, it is difficult to imagine that experience and how ISA affects one’s behavior in traffic. We chose 10 local politicians responsible for traffic safety, one from each of the 10 municipalities in the county of North Jutland. We asked them to have the PAYS equipment installed in their private cars and to use it for at least six months. Four of the ten accepted, one declined and the remaining five declared themselves in favor of the idea, but in the end, found various excuses for not participating.

After the test-drive period, we interviewed three of politicians who had the system installed in their cars and the one who declined from the beginning to participate in the test. We asked them questions about traffic safety, speed, their experiences using the system and their opinions on ISA in general and PAYS in particular. If the politicians held opinions favorable to ISA, they might act as ambassadors for the system to the public and to national politicians. In the next section, we report and discuss statements from these interviews.

3.3.1. Interviews

As an initial question, the four politicians were asked how they would characterize themselves as drivers. They all began by claiming to abide by traffic rules. However, the three politicians who participated in the test drive made several statements proving that politicians are only human:

“With this device in my car I found out that, actually, I do drive too fast. When I am in a hurry or when I start my trip 15 minutes too late, I would like to be able to exceed the speed limit. And this is exactly the situation where this voice becomes very annoying.” (Politician A)

“This is one of the reasons why I find this system so useful. I used to be a “quick” driver. Perhaps I was not exactly aggressive, but I was one of those drivers who always leave home a little too late. I would excuse myself thinking ‘I have to go fast because I have to be in time for my meeting.’ I do not do that anymore.” (Politician D)

“I use my car a lot. I drive reasonably. But when I had the ISA equipment in my car, I was constantly reminded… that I was exceeding the speed limits.” (Politician C)

These local politicians had various opinions on the different features of the system. To those who wanted to decide for themselves whether to exceed speed limits, the PAYS system was annoying.

Politician A said: “I do not want this voice in my car at all… I want to be able to exceed the speed limit outside the cities. You don’t want to be the one delaying everyone because you abide by all the rules. You have to keep moving. Precisely in that respect the ‘Pay As You Speed’ system is very annoying. In many situations it is better to step on the accelerator and clear the spot quickly”.

As the PAYS would be a good idea for others, the only useful situation this politician identified are situations in which young people are learning to drive or have just obtained their driver’s licenses.

Politician B – the one who had not tried PAYS – stated that he did not want the system in his car. However, he conceded that perhaps “something” should be put in the cars. He was not optimistic that young people could be persuaded to use PAYS voluntarily. If ISA were to be implemented, this politician held the view that everyone should use it so that no particular group of drivers would feel “punished or exposed”.

The third politician (C) was in favor of using a system like PAYS to help drivers, especially young men, reduce their speed. He found the system very helpful and had changed his behavior in traffic. He now uses the warning feature in his own navigation system to lower his speed, and he has formed the habit of responding to the warnings. This politician thought the time was right for such a system and spoke of the money spent in the healthcare system on victims of traffic accidents. “If we put together this money, we could spend it on something like this. That could work. Prevention… Polarists
should regulate and legislate in a way which shows consideration for the environment as well as speed and road safety.”

The fourth politician (D) was very enthusiastic about PAYS. He had learned to calculate his travel time more precisely. The stress he had felt disappeared, and it became almost unpleasant to exceed the speed limit. As for the chances of implementing PAYS on the national level, this politician said that the time will never be right; politicians will have to make the necessary decisions. In his opinion, most people would not voluntarily choose a system like PAYS. Therefore, politicians should decide whether the number of traffic fatalities is high enough to necessitate a decision.

3.3.2. Political perspectives on ISA

In conclusion, two of the local politicians were quite positive towards PAYS. The third politician who participated in the test and the politician who did not try the system were rather negative and did not think that local political leaders could play an important role in promoting ISA. All of these leaders believed that national politicians would need to be involved to implement such a system. They did not mention political leaders at the EU level. The interviewees did mention national legislation as the most efficient means of promoting ISA.

When speaking as politicians, local political leaders grasped the problem of excessive speeding and desired reduced speed. When speaking as drivers, however, they admitted to being inclined to break speed limits. Lack of experience with Intelligent Transport Systems in general, aversion to using ISA themselves and the fact that they do not see municipalities as participants in the implementation of ITS or ISA means that local politicians are not likely to make the first move towards testing, promoting or implementing ISA in their local communities.

4. Discussion and concluding remarks

In the PAYS project, we succeeded in developing a reliable and technically advanced ISA system, but we did not reach our goal of 300 young drivers participating in the PAYS project for three years; instead, we procured 153 participants of all ages. Our first plan for the project included a fee of €700 combined with a discount on insurance rates, corresponded to a normal, market-based plan, but only 40 drivers signed up under those conditions. The recruitment of a suitable driver population for research purposes developed into a strenuous and unsuccessful struggle. This might be a local, Danish, phenomenon, but it may also reflect a tendency among drivers in general. They may not wish to relinquish the option to speed, even for economic gain.

In fact, even an economic incentive in the form of a 30% insurance discount was not sufficient to persuade many drivers to use this equipment. The strenuous and unsuccessful efforts to recruit participants for the project led us to conclude that large psychological barriers must be overcome before young motorists will permit the installation of ISA in their cars. The financial incentive offered was far from enough for car owners in the county of North Jutland to accept ISA over an extended period of time. In principle, the target group was favorable to ISA and the PAYS project, but when it came to installing an OBU in their own cars, they invariably found excuses for refusing to do so. Prospective participants supplied many excuses, with the predominant one being the drivers’ desire to remain free to speed if they desired.

Removing the age limit did not change this pattern. It was not possible by any reasonable means to reach the goal of 300 participants in this project. In fact, only 0.14% of all car owners in North Jutland and 0.9% of Topdanmark customers in North Jutland volunteered to participate in the field trial. Moreover, of the 10 local politicians with responsibility for traffic safety that the plan projected as possible ambassadors for the project and who would have ISA equipment installed in their private cars, only four participated. Interviews suggested that even politicians with a positive attitude to ISA did not see a role for themselves in implementing ISA. With regard to speeding, one of the politicians made very clear her resistance to ISA and her desire to retain the ability to speed.

Taken as a whole, the reluctance of young and experienced motorists to participate in this project and the corresponding lack of enthusiasm on the part of politicians with local responsibility for traffic safety suggests that public opinion in Denmark considers speeding to be permissible. This attitude to speeding is probably the greatest obstacle to the general implementation of ISA in Denmark.

Unfortunately, the main conclusion to be drawn from this project—the failure to recruit participants—is apparently inconsistent with the results of most other ISA projects. Positive results from using ISA have generally been reported, and no problems related to the recruitment of participants to ISA projects have been reported or discussed in any previous studies. The intent of the PAYS project was to simulate a market situation, whereas the previous ISA studies have included one or more of the following conditions: (1) ISA coverage of only a limited number of roads; (2) the provision of a project car, free of charge; (3) only a few young drivers participating; and (4) a short test period. All of these factors tend to reduce the general validity and reliability of the test results obtained. The fact that 20 years of positive results from ISA research have not stimulated the commercial introduction of ISA-equipped cars or OBUs on the ITS aftermarket (except in Sweden, where it is possible to buy a fleet management system with an ISA function [www.sepab.se]) leaves the impression that there is no demand for ISA on the market either in Denmark or elsewhere. Because ISA is a promising and technically sound safety system, introducing ISA in road traffic will require action beyond waiting for market forces to operate. If we divide drivers in three groups with respect to their attitude to ISA, (1) those who need ISA but do not want it, (2) those who need ISA and accept it after having tried it, and (3) those who want ISA but do not need it, a market-based strategy predicated on the voluntary use of ISA will reach only Group 3. For ISA to reach Groups 1 and 2, we require alternatives to purchasing ISA on the market. The following are alternative methods for implementing ISA. (1) Mandatory ISA for selected groups with a high risk of accidents, such as inexperienced young drivers. Inexperienced drivers would be required to practice proper speed control by driving 20,000 km in a car equipped with a recording ISA system prior to receiving a full driver’s license. (2) Mandatory ISA to be included in the catalogue for speeding sanctions to enhance compliance with speed limits, in much the same way as the Alco lock is currently deployed to prevent drinking and driving in such countries as Sweden and Finland (Danish Ministry of Justice, 2010). (3) Mandatory ISA in cars performing public services and support for companies installing ISA in their cars.

Finally, based on the PAYS results, we can conclude that ISA is technically ready for market introduction, but also that ISA is not market driven. To implement ISA on a large scale, society must both legislate its use and actively support the voluntary adoption of the system.

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