Cost benefit analysis of the Irish alcohol interlock program

R-2020-31

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Prevent crashes
Reduce injuries
Save lives

Report documentation

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Title: Cost benefit analysis of the Irish alcohol interlock program
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Contents of the project: The Road Safety Authority (RSA) of Ireland has commisioned SWOV to undertake a cost benefit analysis (CBA) of an alcohol interlock program (AIP) according to action 121 of the Government Road Safety Strategy 2013-2020. In an AIP, vehicles of car and van drivers who repeatedly drink and drive are instrumented and can only function if the driver is sober. Experience in other countries has proven this measure can prevent drink-driving and thus save lives and prevent injuries. Using Irish statistics and best estimates for effectiveness based on the literature, a CBA method was developed and modelled. The outcome of this model shows an Irish AIP is likely to entail (far) more benefits than costs. The best estimate for the benefit to cost ratio (BCR) is 6.1 and the net present value (NPV) 52 million euros. As for all models, results depend on assumptions and uncertainties, and therefore a sensitivity analysis was added. The output appears to be sensitive to (especially) participation rate, effectiveness and general road safety trends. However, in all variations both BCR and NPV are positive, i.e. benefits outweigh costs.

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Glossary

Action 121: Action 121 of the Government Road Safety Strategy 2013-2020 requires the Road Safety Authority and supporting departments to undertake a cost benefit analysis for the use of alcohol interlocks in Ireland as a sanction for repeat offenders.

AIP: Alcohol Interlock Program

Base Year: A base year is the year used for comparison in the measure of a business activity or economic index. For example, to find the rate of inflation between 2005 and 2010, make the calculations using 2005 as the base year, or the first year in the time set.

Benefit to cost ratio (BCR): is an indicator, used in cost benefit analysis, that attempts to summarise the overall value for money of a project or proposal. All benefits and costs should be expressed in discounted present values.

CBR: The Dutch Driver and Vehicle Licensing Centre.

Ceteris paribus: This commonly-used phrase stands for 'all other things being unchanged or constant'. It is used in economics to rule out the possibility of 'other' factors changing, i.e. the specific causal relation between two variables is focused.

Common Appraisal Framework (CAF): a common framework for the appraisal of transport investments that is consistent with the Public Spending Code (PSC) and comparable business cases for submission to the Irish Government.

Cost benefit analysis (CBA): comparison of the costs and benefits associated with alternative ways of achieving a specific objective. Monetary values are assigned to both costs and benefits in a CBA.

CSO: Central Statistics Office.

Discount rate: used to convert costs and benefits to present values to reflect the principle of time preference. The official discount rate of 5% has been set by DPER in Section E of the Public Spending Code (PSC). This discount rate should be applied in all appraisals. See present value definition for more information.

DUI: Driving under the influence of alcohol.

Do nothing: this option requires a clear description of what is likely to occur in the absence of the intervention. In this CBA, this would include carrying on as usual with no policy intervention implemented, i.e. there would be no Alcohol Interlock Program implemented.

Do something: The options that are available to address the objective of the intervention, i.e. in this analysis, this would be the implementation of an AIP.

DPER: Department of Public Expenditure and Reform

DTTaS: Department of Transport, Tourism, and Sport

DVCSD: Driver and Vehicle Licensing Computer Services Division (DVCSD), Department of Transport in Shannon.

SRAD: Strategic Research and Analysis Division in the Department of Transport, Tourism and Sport.

ITF: International Transport Forum

Net Present Value (NPV): this is the sum of the discounted benefits (i.e. the monetised benefits that the discount rate has been applied to) minus the sum of the discounted costs (i.e. the costs that the discount rate has been applied to).

Present Value: As the impacts included in CBAs are expressed in monetary terms, all monetised costs and benefits arising in the future need to be adjusted to take account of this phenomenon known as 'time preference'. The technique used to make this adjustment is known as discounting. A 'discount rate', which represents the extent to which people prefer current over future consumption, is applied to convert future costs and benefits to their 'present value', the equivalent value of a cost item or benefit in the future occurring today.

Public Spending Code (PSC): The set of rules and guidelines that all civil and public bodies must follow when considering, incurring, or monitoring expenditure.

Principle of time preference: time preference is the relative valuation placed on a good at an earlier date compared with its valuation at a later date.

RSS: The Government Road Safety Strategy 2013-2020.

SB 104: Statutory basis 104 refers to: "A person shall not drive or attempt to drive a mechanically propelled vehicle in a public place while he or she is under the influence of an intoxicant to such an extent as to be incapable of having proper control of the vehicle."

SB 105: Statutory basis 105 refers to: "A person commits an offence if, when in charge of a mechanically propelled vehicle in a public place with intent to drive or attempt to drive the vehicle (but not driving or attempting to drive it), he or she is under the influence of an intoxicant to such an extent as to be incapable of having proper control of the vehicle."

Repeat Drink-driver: For the purposes of Action 121 a repeat drink-driver is defined as someone who has been convicted in court for driving under the influence two or more times over the period of 2006 – 2016, i.e. drivers who have received a conviction in court for an SB104 and/or for an SB105 offence.

RDW: State Department for Road Traffic in the Netherlands (RijksDienst voor het Wegverkeer - RDW)

RTC: Road traffic collision

WHO: World Health Organisation

Executive summary

Drink-driving is a major factor in road crashes, fatalities and injuries. Legislation, enforcement, education etc. have proven to be effective in bringing drink-driving levels down. However, still too many drivers repeatedly drink and drive and pose a substantial threat to road safety. This group is not sensitive to 'traditional' drink-driving measures. Several countries have, therefore, implemented an alcohol interlock program (AIP). The alcohol interlock is a breathalyser device that prevents the vehicle from starting if the driver is not sober. When the driver blows into the device, an alcohol-specific sensor analyses the breath sample and calculates the blood alcohol concentration (BAC). The engine can be started only if the BAC is below the designated limit. An Alcohol Interlock Program offers offenders who would normally lose their licence the opportunity to continue driving, as long as they are sober. Preventing these offenders from driving under the influence of alcohol will have a positive effect on the number of road crashes, fatalities and injuries.

The Irish Government Road Safety Strategy 2013-2020 (RSS) sets out 144 actions for the Road Safety Authority (RSA) and stakeholders to have completed by 2020. Action 121 requires RSA to "Undertake a cost benefit analysis for the use of alcohol interlocks as a sanction for repeat offenders." RSA has commissioned SWOV, the Dutch road safety research institute, to do this.

In Ireland, a large number of people are convicted for drinking and driving. The share of repeat offenders from 2013 to 2016 was 13% on average. For the purpose of this study, this percentage was used in the cost benefit analysis.

The main goal of this study is to determine the two elements of the desired cost benefit analysis: the benefit to cost ratio (BCR) and net present value (NPV) of an Irish Alcohol Interlock Program (AIP). To meet this goal, six research questions on the AIP need to be answered, regarding *the* number of casualties *to be* reduced, characteristics of the program, effectiveness, methodology and data, BCR and NPV for different scenarios, and sensitivity to the most relevant input parameters.

The CBA covers a 10-year timeframe (2021-2030) with three different casualty development trends being considered. The most likely trend is based on a model. A more positive trend is the supposed result adhering to EU policy, assuming numbers will be halved in a decade. A more negative trend assumes road fatalities stay at the 2018 level.

The AIP is assumed to be a two-year mandatory program for the participant who bears the cost of the program, as is general practice internationally (e.g. Netherlands, Sweden, Finland and France). In addition, the CBA also includes an alternative AIP scenario where costs are fully borne by the state of Ireland. This is done because it will have a positive effect on participation rate and subsequently the benefits of the program.

In all scenarios, the BCRs and NPVs are favourable. The most likely implementation of the AIP, will result in a BCR of 6.1 and an NPV of 52 million euros. This implies an Irish AIP is likely to be efficient and effective. The output of a model is sensitive to variations in the used input parameters and these have been detailed in the report.

Contents

1 Introduction

Drink-driving is a major factor in road crashes, fatalities and injuries. Legislation, enforcement, education etc. have proven to be effective in bringing drink-driving levels down. However, still too many drivers repeatedly drink and drive and pose a substantial threat to road safety. This group is not sensitive to 'traditional' drink-driving measures. Several countries have therefore implemented an alcohol interlock program (AIP). The alcohol interlock is a breathalyser device that prevents the vehicle from starting if the driver is not sober. When the driver blows into the device, an alcohol-specific sensor analyses the breath sample and calculates the blood alcohol concentration (BAC). The engine can be started only if the BAC is below the designated limit. An alcohol interlock program offers offenders who would normally lose their licence the opportunity to continue driving, as long as they are sober. Preventing these offenders from driving under the influence of alcohol will have a positive effect on the number of road crashes, fatalities and injuries.

In Ireland, a large number of people are convicted for drinking and driving, an average of 13% (between 2013-2016) of them for repeat offences. To reduce the number of repeat offenders, an AIP could become part of the Irish road safety strategy if a cost benefit analysis proves this to be efficient and effective.

The Irish Government Road Safety Strategy 2013-2020 (RSS; RSA, 2013a) sets out 144 actions for the Road Safety Authority (RSA) and stakeholders to complete by the end of 2020. As described in *Table 1.1*. Action 121 requires RSA to 'Undertake a cost benefit analysis for the use of alcohol interlocks as a sanction for repeat offenders'. RSA is the lead agency for this action and the support departments are:

- An Garda Síochána (AGS)
- The Department of Justice and Equality (DJ&E)
- The Medical Bureau of Road Safety (MBRS)

Table 1.1. Action 121 of the RSS (RSA, 2013a)

Number	Action	Lead agency or department	Responsibility	Completion date	Support department or agency
121	Undertake a cost benefit analysis for the use of alcohol interlocks as a sanction for repeat offenders	RSA	Director - Road Safety, Research & Driver Education	Q1 2014	AGS/MBRS/ DJ&E

This report presents the requested cost benefit analysis of the introduction of an alcohol interlock program (AIP) in Ireland.

1.1 Goal

The goal of this study is to determine the two elements of the desired cost benefit analysis: the benefit to cost ratio (BCR) and net present value (NPV) of an Irish Alcohol Interlock Program (AIP). This includes several scenarios for an AIP and a sensitivity analysis using a variety of parameters.

1.2 Research questions

To meet the goal of this study the following research questions (RQ) need to be answered:

1. What is the number of casualties *to be* reduced by the AIP?
2. What are the probable characteristics of the (Irish) AIP?
3. How effective is an AIP and which elements determine this effectiveness?
4. Which methodology and data are used to determine the BCR and NPV?
5. What are the BCRs and NPVs for different scenarios?
6. How sensitive is the outcome (i.e. BCR and NPV) to the most relevant parameters?

1.3 Research methods

The methodology follows the Irish Common Appraisal Framework (CAF) as much as possible. The CAF is best practice to evaluate transport projects and programs in Ireland. The purpose of following this framework is to ensure a common framework for the appraisal of transport investments that is consistent with the Public Spending Code (PSC) and comparable business cases for submission to the Irish Government (DTTaS, 2016). Furthermore, the report draws on findings from preliminary analyses carried out by RSA internally. These analyses concerned the costs and benefits associated with the implementation of an AIP in Ireland.

The first research question (RQ1: target group of an AIP) is addressed by using statistical data. Where possible, the present CBA references the most recent Irish data. As an AIP had not previously been introduced in Ireland, for some inputs in this report it was necessary to use international data to best estimate the costs and benefits associated with an AIP. It is important to note that the present CBA is based on many assumptions, specifically in relation to the details of the AIP. In order to relate the Irish situation to results found elsewhere, a comparison of road safety and drink-driving between Ireland and other countries is made.

For RQ2 (characteristics Irish AIP) and RQ3 (Effectiveness) we undertook a brief scan of the literature to identify recent studies on alcohol interlock effectiveness and conditions that may affect this effectiveness. It is assumed that the AIP is for repeat drink-drivers only, the program is mandatory for 2 years, and does not include a rehabilitation program. The AIP is assumed to start after an average 12-month disqualification period in which drivers are not allowed to drive at all. The CBA was conducted over a 10-year time horizon. For policy makers it is important to know what alternative measures exist in order to make the right decisions. Therefore, alternatives to an AIP are provided as well.

The methodology (RQ4) addresses the costs and benefits of the AIP, compared to current policy (base case). Consequently, costs and benefits of current policy will only be part of the CBA if relevant for comparison purposes. For example, some costs made in current practice can be avoided when introducing the AIP. Therefore, these are benefits of the AIP. Mobility benefits will be estimated on the basis of changes in modal shift and the related cost changes (e.g. vehicle costs and time costs).

The NPV and BCR of a most likely base case and several alternative scenarios (RQ5) are calculated with a tailored computer program (Dplyr and Openxlsx in “R”) based on the methodology (RQ4) and using the available data (e.g. RQ1). Important elements in the scenarios are the future casualty trends (2021-2030), assumed level of effectiveness of the AIP, and participation rate, which differs depending on the party bearing the costs: the participant or the state.

A sensitivity analysis is conducted (RQ6) for the most relevant variables. Suitable upper and lower limits of values are taken and the R program is used to vary the input parameters randomly (Monto Carlo scheme, n=10,000) within a scenario.

1.4 Organisation of the report

This report is organised as follows:

- *Chapter 2* presents Irish data on Irish offender statistics on drinking and driving, the alcohol-related road toll in Ireland, and compares Ireland with other countries on alcohol-related road safety indicators (RQ1).
- *Chapter 3* presents the scientific knowledge on AIP - including a further examination of recent effectiveness estimates, and to what extent these estimates may be applicable to Ireland - and describes the elements of the proposed AIP for Ireland. It also describes some alternative approaches to an AIP and their effectiveness (RQ2 and RQ3)
- *Chapter 4* describes the method used to carry out a CBA for an AIP in Ireland, the different scenarios for the CBA and the sensitivity analysis (RQ4 (5, 6))
- *Chapter 5* presents the results of the CBA using different scenarios and sensitivity settings (RQ5, RQ6).
- *Chapter 6* presents the conclusions by giving the main answers to the research questions and subsequently achieving the main goal, which is the NPV and BCR of a base case Irish AIP, several scenarios and their sensitivity to variations in the most relevant parameters.

2 Alcohol and road safety

This chapter will present offender statistics on drinking and driving in Ireland (*Section 2.1*), the alcohol-related road toll in Ireland (*Section 2.2*), and comparative statistics of Ireland and other countries on alcohol-related road safety indicators (*Section 2.3*).

2.1 Offender statistics drink-driving Ireland

An AIP would target the population of Irish repeat alcohol offenders. Therefore it is important to have an estimate of the annual number of convicted repeat offenders in Ireland.

To estimate the number of convicted repeat DUI offenders in Ireland, disqualification data for drivers over the period of 2006-2016 are used. These data include those who were disqualified after receiving a conviction for breaching Section 4 or Section 5 of the Road Traffic Act 2010 (SB104 or SB105 regarding alcohol).

On average, between 2006 and 2016, 5,399 drivers were convicted for driving under the influence of alcohol annually (*Table 2.1*). This is excluding drivers who received penalty points for drink-driving.[1]

Table 2.1. Disqualifications for an SB104 and/or SB105 2006-2016[2]

Start year of the disqualification	Number of offenders	Number of repeat offenders (two or more convictions)	% of repeat drink-drivers per year
2006	7,489	344	5%
2007	8,042	179	2%
2008	7,954	372	5%
2009	6,560	472	7%
2010	5,953	529	9%
2011	5,300	573	11%
2012	4,430	484	11%
2013	4,095	471	12%
2014	3,848	482	13%
2015	3,086	447	14%
2016	2,630	362	14%
Average	5,399	429	9%

1. http://www.irishstatutebook.ie/eli/2010/act/25/enacted/en/html
2. These data have been obtained from the Driver and Vehicle Computer Services Division (DVCSD) of DTTaS in 2017.

Though the total number of convicted drink-driving offenders decreased between 2006 and 2016, the share of repeat offenders increased. This indicates that traditional drink-driving measures are not effective for reducing this group of offenders. From 2013 to 2016, the share of repeat offenders is 13% on average. This percentage will be used for the calculations in the new cost benefit analysis.

2.2 Alcohol-related road toll

In recent years, a number of good-quality studies have been published that calculate the effect of AIP programs on fatal road crashes and fatalities in the United States (Kaufman & Wiebe, 2016; McGinty et al., 2016; Teoh et al., 2018). *Sections 3.3.2* and *3.3.3* explain why it is justifiable to apply USA reduction estimates to the Irish context. Detailed information about the USA studies is provided in the Appendix. To apply the USA reduction estimates to Irish data we need recent estimates of all Irish alcohol-related fatalities.

In the next sections, estimates are given for Irish alcohol-related road fatalities (*Section 2.2.1*), alcohol-related serious injuries (*Section 2.2.2*) and alcohol-related minor road injuries (*Section 2.2.3*). The proposed AIP (further described in *Section 3.2*) includes car and van drivers and excludes motorcyclists and HGV drivers.

2.2.1 Estimation of the number of alcohol-related fatalities

In 2016, RSA published a report examining 867 of the 983 fatal collisions on Irish roads which occurred between 2008 and 2012. The report specifically focused on the role of alcohol in a fatal collision. Alcohol was cited as a contributory factor in 330 (38%) examined collisions. This figure is based on both confirmed alcohol results for the driver, motorcyclist, pedestrian or cyclist and/or the attending Garda's opinion. In certain circumstances, it was not possible to test the suspected road user for alcohol for reasons such as the road user leaving the scene, difficulty in identifying the road user at the scene, medical consent for alcohol testing being refused and refusing to provide a sample. In these circumstances, the opinion of the Garda at the scene, witness statements and, in some instances, admission of alcohol consumption by the road user indicated alcohol as a contributory factor for the collision.

Over the five-year 2008-2012 period (RSA, 2016), 222 drivers consumed alcohol prior to the collision. As a proportion of all 867 fatal collisions analysed, this indicates 26% involved at least one drink-driving driver. We use the number of all alcohol-involved fatal collisions of car or van drivers to calculate the share of alcohol-related fatalities (26%).

From 2018 crash figures (preliminary data provided by RSA), we derive the reduction resulting from an AIP as follows:

- in 2018, there were 114 fatalities ensuing from 108 fatal collisions in which a car or van driver was involved
- of these 114 fatalities, 26% or 30 were estimated to be alcohol-involved fatalities, the number used to estimate the reduction an AIP is meant to achieve (in: *Section 3.3.4*).

2.2.2 Estimation of the number of alcohol-related serious injuries

For fatal collisions, we know from RSA research that 26% involve drink-driving (as mentioned in *Section 2.2.1*). For serious injuries, this share is unknown and the estimate is an adjustment to this 26% based on the literature.

The results of international research studies show that the impact of alcohol is higher on fatal crashes than on injury crashes (Hels et al., 2011). This is mainly because drivers under the influence of alcohol wear their seatbelts less often and drive at higher speeds (Andersen et al., 1990; Desapriya et al., 2006; Isalberti et al., 2011; Li et al., 1999; Jørgenrud et al., 2018).

European research combining eight hospital studies on a.o. seriously injured car drivers showed that the proportion of alcohol-positive drivers varied from 14.9% in Norway to 38.2% in Belgium, the median of these studies being 23.6%. In each of these studies alcohol-impaired drivers were identified as those with a BAC value above 0.05 g/dL. Another European study on deceased car drivers in eight (different) countries, showed that the proportion of alcohol-positive drivers varied from 16.3% in Sweden to 60.9% in Lithuania; the median of these studies was 29.0% (COWI et al., 2014). Based on both studies, we estimate that the proportion of alcohol-involved crashes among deceased drivers is about 25%[3] higher than the proportion of alcohol-involved crashes among seriously injured drivers. For Ireland this means 21% of all seriously injured drivers (26%/1.25=21%).

Based on information on serious injuries in 2018 (preliminary data provided by RSA) the number of annual serious road injuries involving alcohol that can be reduced by the introduction of AIP can be derived as follows:

- The number of serious road injuries in crashes where a car driver was involved was 1089 in 2018 (preliminary data provided by RSA).
- 21% of 1089 serious injuries is 229, i.e. the number of serious injuries on which reduction by the AIP will be assessed (*Section 3.4.3*).

2.2.3 Estimation of the number of alcohol-related minor injuries

Information about the characteristics of minor-injury collisions is rather scarce. In Great Britain, it was estimated that 5% of all casualties in reported road collisions in 2017 involved at least one driver or rider who was over the drink-drive limit (Department of Transport, 2019). Assuming that:

- the percentage of alcohol involvement for all casualties will likely be near the percentage of alcohol involvement for minor casualties, since this percentage is dominated by large numbers of minor casualties,
- drink-driving levels in Great Britain and Ireland are (roughly) similar, and
- given that Ireland has a lower legal limit than Great Britain,

an estimate for the alcohol-involvement in minor injuries for Ireland would realistically be expected to be somewhere between 5-10%. We conclude that a 6% estimate for Ireland would be the best conservative estimate.

The number of annual minor road injuries that can be reduced by the introduction of AIP can be derived as follows:

- minor injuries in car crashes in 2018: 6045 (preliminary data provided by RSA)
- drink-driving involved 6% of 6045, i.e. 363

3. Calculated as 29.0/23.6 = 1.22, given the uncertainties we give a round figure i.e. 25%

2.3 Irish drinking and driving: international comparison

To understand the drink-driving problem in Ireland in its many aspects and to compare it with other countries inside and outside the EU we have looked at a number of indicators:

- alcohol consumption per capita (*Section 2.3.1*)
- prevalence of heavy episodic drinking[4] (*Section 2.3.1*)
- alcohol-attributable road fatalities (*Section 2.3.1*)
- self-reported drinking and driving (*Section 2.3.2*)
- self-confidence in driving after using some alcohol (*Section 2.3.3*)
- personal and social acceptability of drinking and driving (*Section 2.3.4*)
- conclusions (*Section 2.3.5*)

2.3.1 International statistics on alcohol consumption and alcohol-attributable road fatalities

The WHO status report on alcohol and health presents further international statistics on alcohol and road safety (WHO, 2018):

– alcohol per capita consumptions for 15+ population
– prevalence of heavy episodic drinking
– alcohol-attributable percentages of age-standardised road fatality rates

Table 2.2 presents these indicators for Ireland, Canada, USA and other EU countries. The WHO report does not mention an EU average. According to these WHO figures Ireland has higher figures on heavy episodic drinking, and alcohol-attributable road fatalities than Canada, USA and 11 EU countries. For alcohol per capita, Ireland is the second highest country among these countries with only Germany having a higher alcohol consumption.

It should be noted here that the WHO estimated alcohol-attributable percentages of road collisions tend to be higher than the official statistics reported by Ireland and other countries. The WHO method may perhaps tend to overestimate these percentages. However, within the perspective of the present analysis the relative position of Ireland compared to countries on this indicator is the most important finding rather than the exact magnitude of the estimate.

4. WHO "Heavy episodic drinking, or HED, is defined as drinking at least 60 grams or more of pure alcohol on at least one occasion in the past 30 days. HED is one of the most important indicators for acute consequences of alcohol use, such as injuries." https://www.who.int/gho/alcohol/consumption_patterns/heavy_episodic_drinkers_text/en/

Table 2.2. Indicators on general alcohol use and road safety from WHO (2018)

Country	1. WHO 2018: alcohol per capita (2016)	2. WHO 2018: prevalence of heavy episodic drinking* (2016)	3. WHO 2018: alcohol-attributable percentages road deaths males (2016)	4. WHO 2018: alcohol-attributable percentages road deaths females (2016)
Belgium	12.1	32.2%	47.3%	31.2%
Finland	10.7	28.3%	43.4%	28.7%
Denmark	10.4	29.7%	42.9%	26.3%
France	12.6	31.2%	45.9%	39.8%
Germany	13.4	34.2%	48.0%	33.7%
Greece	10.4	23.6%	41.9%	30.0%
Ireland	*13.0*	*37.8%*	*50.8%*	*37.7%*
EU	-	-	-	-
Netherlands	8.7	27.4%	37.2%	26.4%
Poland	11.6	35.1%	48.1%	36.0%
Spain	10.0	25.6%	39.6%	28.3%
Sweden	9.2	28.0%	42.5%	28.6%
United Kingdom	11.4	29.8%	43.8%	32.2%
Canada	8.9	21.2%	38.0%	22.7%
USA	9.8	26.1%	42.5%	25.0%

* Consumed at least 60 grams or more of pure alcohol on at least one occasion in the past 30 days.

2.3.2 Self-reported drink-driving

The international ESRA-2 survey (Achermann Stürmer et al., 2019) presents several questions on drink-driving in traffic and on personal beliefs and standards concerning this behaviour[5]. In 2018, 32 countries participated in the survey, 20 within the EU and 12 outside the EU. In each participating country, about 1,000 respondents filled in the ESRA questionnaire, of which about 700 to 900 car drivers, 300 to 700 hundred cyclists, and 100 to 400 motorcyclists/moped riders.

In this section, we compare answers of Irish road users (car drivers, but for some questions also motorcyclists and moped riders, and cyclists, or all road users) with road users in 11 other EU countries (Belgium, Finland, Denmark, France, Germany, Greece, Netherlands, Spain, United Kingdom, Poland, Sweden) and in 2 other countries outside the EU, Canada and USA. The EU-20 average reported in the tables is the average of all 20 EU countries in ESRA (Austria, Belgium, Finland, Czech republic, Denmark, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Spain, United Kingdom, Poland, Portugal, Serbia, Slovenia, Sweden, Switzerland).

5. Information on the ESRA2 project can be found on: https://www.esranet.eu/

As we can see in *Table 2.3,* some EU countries, such as Belgium, France and Greece, score higher than the EU average on self-reported drink-driving of car drivers in the past 12 months and past 30 days (columns 1 to 3). Ireland scores below EU average on these questions, and also below levels in Canada and the USA. On the indicator "I often drive after drinking alcohol," all percentages are quite low, but Ireland's 3% is somewhat above average. In terms of self-reported drink-driving of motorcyclists and moped riders, Ireland scores somewhat above average. For alcohol-impaired cycling Ireland scores slightly below average.

Table 2.3 presents answers to questions on self-reported drinking and driving in traffic.

Table 2.3. Self-reported drinking and driving of road users in Ireland, EU countries, Canada and USA; columns 1-4: car drivers; column 5: motorcyclists/ moped riders; column 6: cyclists).

Country	**1. Drive after drinking alcohol in the past 12 months**	**2. Drive when I may be over the legal limit for drink-driving past 30 days**	**3. Drive after drinking alcohol in past 30 days**	**4. I often drive after drinking alcohol**	**5. Ride when I may have been over the legal limit for drink-driving in the past 30 days**	**6. Cycle when I think I have had too much to drink**
Belgium	35.0%	24.1%	33.1%	3.1%	21.2%	28.2%
Finland	9.5%	4.1%	9.3%	0.5%	5.4%	21.2%
Denmark	26.9%	11.6%	26.6%	2.0%	28.1%	27.8%
France	29.8%	22.3%	28.9%	2.4%	33.6%	17.5%
Germany	21.2%	8.9%	18.2%	2.0%	18.0%	17.3%
Greece	34.0%	19.3%	27.7%	1.3%	16.3%	7.9%
Ireland	*16.3%*	*10.7%*	*12.2%*	*3.0%*	*22.2%*	16.1%
EU-20	**22.0%**	**13.1%**	**20.6%**	**2.3%**	**19.9%**	**17.4%**
Netherlands	22.3%	9.1%	21.1%	2.4%	18.5%	26.2%
Poland	7.2%	6.4%	6.8%	1.4%	13.9%	15.8%
Spain	26.9%	17.1%	24.7%	2.7%	20.1%	11.5%
Sweden	7.8%	7.0%	7.7%	1.1%	18.1%	28.9%
United Kingdom	19.7%	8.8%	17.9%	3.8%	39.2%	22.3%
Canada	28.3%	14.5%	25.9%	4.3%	52.8%	22.0%
USA	21.3%	11.1%	21.2%	2.2%	21.1%	15.7%

2.3.3 Self-reported faith in the ability to drive under influence of alcohol

Table 2.4 presents ESRA statistics on self-reported faith in driving ability when under the influence of alcohol.

On the indicator "I trust myself to drive after alcohol consumption," Irish respondents score higher (19.5%) than the EU-average (13%), and also somewhat higher than respondents in Canada (16%) and the USA (15%). On the other hand, Irish respondents score somewhat below average on the indicator "I am able to drive after drinking a large amount of alcohol" (2.4% versus EU average 3.4%, and Canada 5.0% and USA 2.1%)

Table 2.4. Self-reported faith in driving ability after drinking, of car drivers in Ireland, EU countries, Canada and USA

Country	**1. For short trips one can take the risk**	**2. I trust myself to drive after alcohol cons.**	**3. I have the ability to drive when I am a little drunk**	**4. I am able to drive after drinking a large amount of alcohol**
Belgium	3.9%	14.5%	7.1%	6.4%
Finland	0.9%	12.0%	2.1%	2.3%
Denmark	1.8%	23.9%	2.4%	1.7%
France	3.2%	14.0%	5.8%	3.4%
Germany	2.0%	17.6%	4.3%	3.5%
Greece	5.9%	19.8%	3.3%	4.6%
Ireland	*3.3%*	*19.5%*	*4.3%*	*2.4%*
EU-20	**3.1%**	**13.0%**	**4.4%**	**3.4%**
Netherlands	3.5%	13.9%	4.1%	3.3%
Poland	2.7%	4.1%	2.6%	2.3%
Spain	4.0%	8.9%	4.2%	3.3%
Sweden	1.6%	4.9%	2.4%	1.8%
United Kingdom	3.7%	11.3%	3.4%	3.1%
Canada	4.8%	16.1%	6.4%	5.1%
USA	3.0%	15.2%	3.5%	2.1%

2.3.4 Reported personal and social acceptability of drinking and driving

Table 2.5 presents results on ERSA questions on social and personal acceptability of driving a car when the respondent may have been over the legal limit. Again, EU respondents in Belgium and Greece tend to show the greatest acceptability of drinking and driving, whereas Irish respondents score below average on personal acceptability (column 3) and on acceptability by their friends (column 1). On one indicator "how acceptable would most other people say it is for a car driver to drive when he/she may be over the legal limit for drinking and driving," Irish respondents score slightly (4.1%) above EU-average (2.6%), while some countries, such as Greece (8.1%), Belgium (4.6%), and France (4.6%), have higher scores. When asked about their personal acceptability of drink-driving, Irish respondents score slightly lower than the EU-average. This might be positive for the acceptance of (additional) drink-driving measures.

Table 2.5. Personal and social acceptance of drink-driving in Ireland, other EU countries, Canada and USA

Country	1. Many of my friends would drive after having drunk alcohol	2. How acceptable would most other people say it is for a car driver to drive when he/she may be over the legal limit for drinking and driving	3. How acceptable do you, personally, feel it is for a car driver to drive when he/she may be over the legal limit for drinking and driving
Belgium	12.2%	4.6%	3.1%
Finland	1.7%	0.7%	0.2%
Denmark	4.5%	1.7%	0.9%
France	6.5%	4.6%	2.3%
Germany	4.6%	4.6%	2.2%
Greece	13.5%	8.1%	1.2%
Ireland	*6.6%*	*4.1%*	*1.6%*
EU-20	**7.4%**	**2.6%**	**1.9%**
Netherlands	5.9%	1.3%	1.1%
Poland	5.6%	6.1%	2.1%
Spain	8.8%	4.3%	1.4%
Sweden	2.1%	1.8%	1.5%
United Kingdom	6.7%	2.9%	2.8%
Canada	7.1%	3.7%	3.0%
USA	10.3%	4.2%	1.4%

2.3.5 Conclusions

An international perspective from a WHO-study (WHO, 2018) shows Ireland has higher than average scores on alcohol consumption per capita, on prevalence of heavy episodic drinking and also quite high percentages of alcohol-attributable road fatalities. However, the WHO-percentages are usually higher than official statistics. For Ireland *Table 2.2* (WHO) shows 50.8% for male road users and 37.7% for females, both much higher than the 26% mentioned in *Section 2.2.1*. Therefore, WHO figures for Ireland should only be interpreted as a means for international comparison.

In addition to WHO, an international survey among road users - ESRA-2 (E-Survey of Road users' Attitudes; Achermann Stürmer et al., 2019) - shows that the self-reported drink-driving percentages of Irish drivers are somewhat below the average among drivers in European countries. In general, ESRA-2 results suggest that Irish drivers have average self-reported beliefs or standards concerning drinking and driving.

All in all, it seems that statistics show that drink-driving, on average, is more of a problem in Ireland than in most other countries, although a (more recent) study on self-reported behaviour shows the opposite.

3 Background AIP

This chapter presents background information on an AIP in general (*Section 3.1*), a description of the proposed Irish AIP (*Section 3.2*) and a discussion on information that is relevant for estimating the effectiveness of an (Irish) AIP, including an estimation of a range of installation rates, and crash reduction information from recent best estimate studies (*Section 3.3*).

3.1 AIP general

What is an alcohol interlock device?
The alcohol interlock is a breathalyser device that prevents the vehicle from starting. When the driver blows into the device, an alcohol-specific sensor analyses the breath sample and calculates the blood alcohol concentration (BAC). The engine can be started only if the BAC is below the designated limit. The ignition interlock device makes sure that drivers can only start the engine after having completed a breath test that has indicated that they are sober.

Why should alcohol interlocks be used?
As part of the RSS 2013-2020, it is a priority to develop a road safety culture in Ireland with specific regard to drink-driving (RSA, 2013a; p. 18). As the data suggest, a high number of people continue to be convicted for drink-driving in Ireland. Of these offenders, it was estimated that between 2013 and 2016 an average of 13% received two or more convictions for drinking and driving, indicating that these offenders continue to drink and drive and do not change their behaviour. To tackle this issue, an AIP could be introduced to reduce the incidence of drink-driving on Irish roads, and ultimately, to prevent a number of fatal and serious injuries. An AIP offers offenders who would normally lose their licence the opportunity to continue driving, as long as they are sober (i.e. below the designated limit), therefore preventing these offenders from driving under the influence of alcohol.

Does the AIP include a rehabilitation course?
For the purposes of Action 121, the AIP program will not include a rehabilitation program, since a separate action is outlined in the RSS to address rehabilitation programs for repeat drink-drivers (Action 107: Legislate for, subject to legal advice, and implement rehabilitation and driving awareness courses as court-based sentencing options for specific offenders).

The European Transport and Safety Council (ETSC) compiled a report on Alcohol Interlocks and Drink-driving Rehabilitation in the EU (Houwing, 2016) which contains profiles on five EU countries. The report outlines that a number of countries do include a rehabilitation course as part of the AIP such as Poland, Austria and Sweden. In Finland, no rehabilitation course is set out as such, but AIP participants must visit a doctor/health care professional to discuss their use of intoxicants before being issued with an alcohol interlock device. The trial period in Finland included several visits to a doctor, but due to the high costs these were excluded from the final program when the AIP became permanent in 2008.

What is the target group of the AIP?
Some driver groups have a much higher involvement in drink-driving collisions than others. One of these groups is the group of repeat offenders, as they persist in drink-driving. Drink-driving recidivism correlates with more frequent crash involvement (Nochajski & Stasiewicz, 2006). For the purposes of this CBA, the target group is repeat drink-drivers: i.e. drivers who were convicted in court for driving under the influence two or more times in the period from 2006-2016 (i.e. drivers who received a conviction in court for an SB104 or for an SB105). The estimated participation rates of the eligible drivers for the AIP is discussed in more detail in section 3 of the methodology.

What is the duration of the AIP?
For the purposes of Action 121, the AIP is assumed to be a two-year mandatory program. This will allow a more accurate estimate of the percentage of repeat drink-drivers who will participate in the AIP. The duration of an AIP varies among countries. In the Netherlands, the AIP was for two years, however if participants drank and drove at any stage of the AIP, the duration of the program was extended. In Sweden, the duration of the AIP varies per offender, it depends on how much the tested BAC level is above the legal limit, hence the program varies between one and three years in length. Finland took the same approach as Sweden, and made participation voluntary. Germany ran a 2-year pilot AIP. Austria conducted two AIP pilots in 2012 and 2013, both of which were two years in duration. Following the successful trials in 2012 and 2013, Austria launched a voluntary rehabilitation program for drink-driving offenders using alcohol interlocks. Convicted drink-drivers can opt in to the scheme to enable them to drive once they have completed half of their driving ban period (minimum of four months). The program was launched in September 2017 (ETSC, 2017).

When will the AIP be started
For maximum benefit, an AIP should be provided in a matter of months after suspension or only as long as it takes to set it up administratively. International best practice will be looked at to support these practical decisions about procedure.

What are the costs of the AIP?
Costs are often cited as a barrier to the use of alcohol interlock devices. The consensus opinion is that a proportion of offenders are unable to afford the cost of an alcohol interlock. This consensus has proved to be a major obstacle to the mandatory use of interlocks and the development of AIPs (Robertson et al., 2017). For the purposes of A121, it will be assumed that the participant bears the cost of the alcohol interlock program, as is general practice internationally (e.g. Netherlands, Sweden, Finland and France and other countries). In addition, a CBA will also be performed for the alternative scenario that the state bears full costs of the AIP.
The costs vary among countries, as each AIP has different criteria to be met and includes different costs, e.g. some AIPs include medical examinations whereas other countries do not. *Section 4.2.1* discusses the costs in more detail.

Who should run the AIP and what are the administration costs of an AIP?
Internationally, there is limited guidance readily available on how the administration of an AIP should be structured in terms of which regulatory bodies should be involved, at what level, and what the associated costs are likely to be. For the purposes of the present CBA, it is necessary to make assumptions on the likely costs for the relevant Irish AIP implementation body. For this paper, the approach in other countries has been reviewed. The Netherlands, Sweden and Finland have specifically been looked at, as these countries provide detailed information on the organisations that implemented the AIP in their country.

In the Netherlands, the Road Traffic Authority (RDW), the Ministry of Infrastructure and the Environment[6] and the Dutch Driving Licence Authority (CBR) ran the AIP. The Ministry of Infrastructure and the Environment defined the setup of the AIP and were responsible for

[6] Now renamed the Ministry of Infrastructure and Water Management

legislation and regulation. CBR were designated by the Ministry to enforce the AIP and were responsible for supporting and monitoring the AIP. RDW were designated by the ministry to administer the interlock data register, were responsible for type approval of interlocks, approval of vendors and installers, and were responsible for supervision.

In Sweden, the Swedish Transport Agency is responsible for the AIP and is responsible for most of the regulation and supervision in the transport sector, and for deciding on permit applications and maintaining records. The Agency has overall responsibility for producing regulations and ensuring compliance. Although a general framework for a statutory use of alcohol interlocks is not in place, local authorities are entitled to require that vehicles are fitted with these devices in case of specific transport, such as school transport.

In Finland, the alcohol interlock is installed in the vehicle by installers that are accredited by the Finnish Transport Safety Agency (Trafi). The National Authority i.e. The Finnish Transport Agency (FTA) must approve the alcohol interlock device.

From brief analysis, it would appear that a combination of bodies is required to collaborate to implement a successful AIP. Based on the experience in the above countries, this combination typically includes, at a minimum:

- A licensing authority
- A body to ensure compliance (similar to Sweden)
- Installers accredited by an appropriate body (i.e. a National Authority similar to Finland)
- A party responsible for legislation (e.g. Transport Ministry)

Should a decision be taken for Ireland to implement an AIP, a discussion among RSA, An Garda Síochána (AGS), the Department of Justice and Equality (DJ&E), the Department of Transport Tourism and Sport (DTTaS) and the Medical Bureau of Road Safety (MBRS) is advised to agree how best to structure an AIP in line with each organisation’s area of remit and capacity.

Regarding the administration costs associated with implementing an AIP, there is limited information available. RSA has consulted the Swedish Transport Agency. The Swedish Agency reported that the average costs over a five-year period (2011-2016) primarily consisted of staff costs and approximately amounted to 11,5 million SEK (€ 1.2 million) a year. The costs for putting the AIP into place were approximately 15 million SEK (€ 1.6 million). The Swedish costs will be used for Ireland as an estimate of administrative costs to set up and implement the AIP. Controlling for inflation and discounting the costs as recommended (CAF, 2016), the total estimated administration costs for an Irish AIP are € 17.3 million calculated over a thirty-year period.

Which vehicles are eligible for the AIP?
It is assumed that the alcohol interlock will only be installed in passenger cars and vans.

3.2 Proposed AIP for Ireland

For the purposes of Action 121, the AIP is assumed to be a two-year mandatory program. This will allow a more accurate estimate of the percentage of repeat drink-drivers who will participate in the AIP.

For the purposes of Action 121, it will be assumed that the participant bears the cost of the two-year alcohol interlock program, as is general practice internationally (e.g. Netherlands, Sweden, Finland and France and other countries). In addition, the present CBA will also calculate, in an alternative AIP scenario, what the costs and benefits would be if the costs of the AIP were fully borne by the state of Ireland.

For this report, evidence from other countries, in particular The Netherlands and Sweden, will be used to estimate the costs of the AIP in Ireland (see *Section 4.2.1*) for passenger cars and vans.

It is assumed that the alcohol interlock will only be installed in passenger cars and vans.

3.3 Effectiveness of an AIP

One of the most important factors that determine the effectiveness of an AIP is the number of participants. In *Section 3.3.1*., attention is paid to this subject, and estimated ranges of installation rates (participation rates) are given for the two scenarios. In the first scenario costs will be fully borne by individuals, in the second costs will be borne by the State. In *Section 3.3.2*., the most recent and best scientific evidence on the effectiveness of AIPs is presented. The best effect estimates come from studies in the USA. The question whether it is likely that effects estimated in the USA can be applied to Ireland is answered in *Section 3.3.3*. Using information from *Sections 3.2.2* and *3.2.3., Section 3.3.4* presents the expected savings in fatalities, serious road injuries and minor injuries due to the introduction of an AIP in Ireland in either of the two scenarios mentioned above.

3.3.1 Installation rates

Evaluation of early alcohol interlock programs indicated that only 10 to 20% of offenders would choose the interlock option over short-term licence suspension (e.g. Marques & Voas 2010; Voas et al. 1999, 2001). In 2013, the installation rate of alcohol interlocks in the USA was still very low with estimates around 20% (GAO, 2014).

In the literature, several reasons are mentioned for not participating: the costs and embarrassment of having the devices in their vehicles, the perceived low risk of getting caught for unlicenced driving, the interlock interfering with drinking and the absence of the need to use a car (Marques, 2010; Voas et al., 2010; TIRF, 2013). These reasons reflect that even if an alcohol interlock program would be free of charge for the offenders, not all drivers would participate in the program.

However, practice has shown that higher installation rates can be achieved if alternative sanctions are harsher or if alcohol interlocks are mandatory for reinstatement of the driver licence (Voas, 2014; GOA, 2014; MADD, 2013).

In recent years, alcohol interlock programs were (re)developed bearing the above in mind. As a result, the average installation rates of mandatory and non-mandatory alcohol interlock programs for convicted drivers in the United States went up from 35.3% in 2014 to 46.9% in 2016, with a median of 50.8% over different states (Robertson et al., 2018; Table 2, p. 11: 50.8% as median value between values 50.0% and 51.5%). These average installation rates are lower than the participation rate of 72% for all drivers who met the criteria of the mandatory Dutch alcohol interlock program from December 2011 to July 2014 (Ministerie van Infrastructuur en Milieu, 2014). This difference may be caused by the fact that the US figures also included non-mandatory programs.

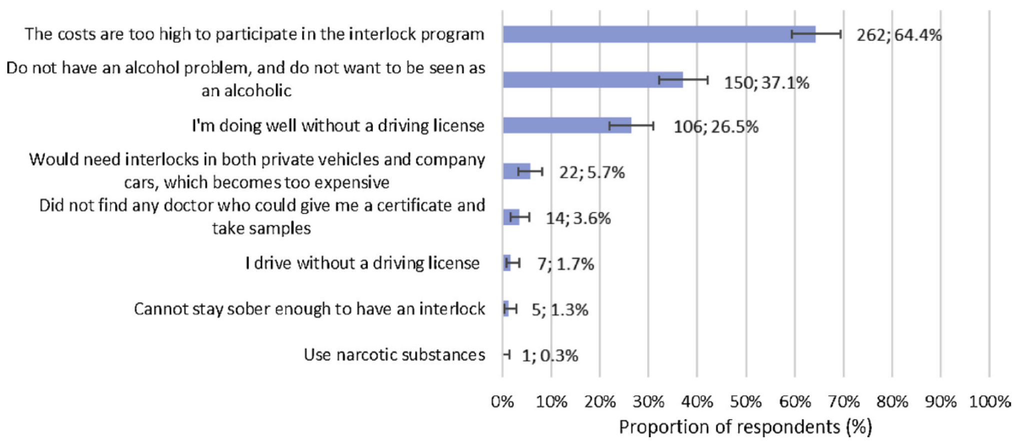
The installation rate for Ireland can be expected to lie between the average for the USA (51%; partly non-mandatory programs) and the participation rate in the Netherlands (72%; mandatory program). Based on this information, we chose an installation rate of 60% for convicted drivers for the mandatory Irish alcohol interlock program as the best estimate. For the sensitivity analysis we include an interval between 50% and 70%.

Participation rates in case all costs of the AIP are financed by the government
Although the participation rates of alcohol interlock programs have increased over the past years, a large proportion of drivers will still not choose to drive with an alcohol interlock device. As stated before, the participation rate is higher in mandatory programs or in programs that are accompanied by alternative sanctions that are regarded as more severe than the alcohol interlock measure.

RSA has asked SWOV to estimate the effect of a program in which all costs are borne by the government. Information to this effect is very hard to find since there are no known programs in which the government bears all the costs. Estimates can therefore only be based on indirect information regarding reasons for non-participation of drivers who were eligible for an alcohol interlock program.

A recent study on the Swedish alcohol interlock program by Forsman & Wallhagen (2019) found that the main reason for not applying for the interlock program was that the costs were too high *(Figure 3.1;* 64.4%). Apart from this, 37.1% of respondents stated that they ”did not have an alcohol problem and did not want to be seen as alcoholics,” and 26.5% stated that “they were doing well without a driving licence" (see *Figure 3.1*). Furthermore, 5.7% found the cost too high since they had to install it in more than one vehicle.

Figure 3.1. Reported reasons for not participating in the Swedish AIP program; numbers of respondents and 95% confidence intervals for percentage estimates added by authors (Forsman & Wallhagen, 2019)



If the most important reason for the Swedish lack of participation is equally important to the Irish, many more Irish offenders would participate if the cost of the alcohol interlock program would be paid by the government instead of the offender. *Figure 3.1* contains two reasons where costs are important, they add up to (64.4% + 5.7%) around 70%. However, this a maximum since respondents could give more than one reason, and therefore *Figure 3.1* adds up to more than 100%. Based on personal communication with the main author of the Swedish paper, it was retrieved that for 29% of the non-participants the single reason for not participating were the high costs. That would be a minimum effect. We therefore estimate that 30-70% of non-participants would enter the AIP if costs were borne by the government.

Consequently, the estimated sensitivity range of the participation rate for the Irish alcohol interlock program would increase by a factor of 1.3 to 1.7, from 50-70% if the drivers paid the costs of the program to 65-90% if the Irish government paid all costs of the alcohol interlock program.

3.3.2 Recent best effect estimates

Early research
Various international studies in the period 1990-2000 show that recidivism of users of an alcohol interlock device is 65-90% lower than that of drivers whose licence was suspended or revoked (Bax et al., 2001). Based on a meta-analysis of high-quality studies, Elder et al. (2011) conclude that an AIP reduces the risk of recidivism by 75% during the period that the measure is operational. No evidence was found for an effect of the alcohol interlock device after it had been removed from the vehicle. A more recent review of alcohol interlock programs (Nieuwkamp et al., 2017) discusses four studies that were published after the study of Elder et al. (2011). These reviewers conclude that the results of the most recent studies are consistent with the findings of Elder et al.: a considerable reduction in the risk of recidivism, but only during the period in which the alcohol interlock device is installed.

There are recent indications that the effects of the AIP may outlast the program itself if the AIP addresses underlying problems of drinking and driving behaviour. The evaluation of the Swedish alcohol interlock program showed that the program resulted in lasting changes in both alcohol consumption and driving behaviour and that it reduced the number of repeat offenders, even after the program had been concluded and the alcohol interlock device had been removed (Bjerre & Thorsson, 2008; Gustafsson & Forsman, 2016). According to the researchers, these lasting changes in Sweden are the result of the integral character of the program: it addresses the cause of the alcohol problem, and not just the symptoms. Another important part of this integral approach is that frequent medical checks continue after the removal of the alcohol interlock device (Bjerre & Thorsson, 2008).

Recent estimates
The first generation of studies on the effectiveness of an AIP focused on the effects of these programs on recidivism. In early effectiveness estimates, the effects on recidivism were used together with a set of underlying assumptions to estimate the prevented alcohol-related road toll. However, in more recent years, a number of good-quality studies have been published that directly calculate the effect of AIP programs on fatal road crashes and fatalities in the United States (Kaufman & Wiebe, 2016; McGinty et al., 2016; Teoh et al., 2018). Below, we describe the evidence from these studies and we propose selecting the ensuing best reduction estimate..

For three reasons, the new safety estimates from recent USA studies (published in 2015-2018) are likely better than the early estimates. First, the new estimates include a general prevention effect of the introduction of the AIP, i.e. the effect of the introduction of the new measure on the larger group of drink-driving car drivers that have not been caught drink-driving, but that have read, heard or seen something about the measure (television, internet, friends, social media etc). The general prevention effect was ignored in earlier estimates based on recidivism figures, since it is very problematic to assess this effect. Second, the new estimates are based on real data instead of sometimes weakly supported assumptions. Third, the new estimates often regard a longer time period so that they include changes over time, whereas assumption-based estimates often rely on fixed-time variable values that ignore long-term changes.

The Appendix presents a description of method and results of four USA studies. In this section, we limit ourselves to two studies concerning the effect of an AIP on repeat offenders. The two studies, McGinty et al. (2016) and Teoh et al. (2018), present evidence about this. The effect estimates of these studies are presented in *Table 3.1.* An important distinction between the two studies is that McGinty et al. estimate a safety effect on alcohol-involved motor vehicle crashes, whereas Teoh et al. estimate a safety effect on the number of alcohol-impaired drivers in fatal crashes. In both studies, the reduction is estimated to be somewhere around 2% to (slightly over) 3%.

Arguably, the best estimates are from the McGinty et al. 2016 study. This study has several advantages over other studies: the longest time frame (1982-2013); data on a monthly level; data on crash level (instead of individual fatalities such as in Kaufman & Wiebe 2016); separate estimates for crashes ≥ 0.08 BAC and ≥ 1,5 BAC; and several sensitivity analyses. According to this study (see *Table 3.1*), the best minimal estimate of alcohol interlock programs is a 1% reduction of fatal alcohol-related crashes and the best maximum estimate is a 3% reduction of fatal alcohol-related crashes.

Table 3.1. Estimates of effectiveness of AIP laws for repeat offenders based on USA studies.

Study characteristic	McGinty et al. 2016	Teoh et al. 2018
Type AIP law	Partial interlock laws, usually for repeat offenders or for repeat offenders and high BAC. In most states, repeat offenders are (adult) drivers caught twice for DUI with BAC ≥ 0.08 in a period of 5 years.	Interlock laws for repeat offenders. In most states, repeat offenders are (adult) drivers caught twice with BAC ≥ 0.08 in a period of 5 years.
Road safety outcome measure	a. Alcohol-involved fatal motor vehicle crashes with BAC ≥ 0.08 b. Alcohol-involved fatal motor vehicle crashes with BAC≥ 0.15	a. Impaired drivers in fatal crashes with BAC ≥ 0.01 b. Impaired drivers in fatal crashes with BAC ≥ 0.08 c. Impaired drivers in fatal crashes with BAC ≥ 0.15
Estimated effect	a. Effect on alcohol-involved fatal motor vehicle crashes with BAC ≥ 0.08: OR = 0.98 (2%reduction), 95%-confidence levels 0.97- 0.99; $p < 0.035$ b. Effect on alcohol-involved fatal motor vehicle crashes with BAC ≥ 0.15: OR = 0.97 (3% reduction), 95%-confidence levels 0.95- 0.98; $p < 0.001$	a. Effect on number of impaired drivers in fatal crashes with BAC ≥ 0.01: 2.7% reduction (N.S.) b. Effect on number of impaired drivers in fatal crashes with BAC ≥ 0.08: 2.6% reduction (N.S). c. Effect on number of impaired drivers in fatal crashes with BAC ≥ 0.15: 3.2% reduction (N.S)

3.3.3 Applicability of USA effect estimates to Ireland

In *Section 3.3.2,* we presented recent evidence from the USA about the effectiveness of the AIP. Such detailed and high-quality effectiveness studies do not currently exist for other countries that may be more comparable to Ireland in terms of demographics and road safety culture/status. A question that needs to be answered is to what extent the effectiveness ratings obtained in USA, reported in the previous section, are relevant for Ireland?

There are differences between Ireland and the USA that may affect how effective a particular USA measure would be if it were applied in Ireland. The more specific question then becomes: are there factors contributing to AIP effectiveness that are different in Ireland than in the USA? We have looked at three such factors which we believe may affect AIP effectiveness:

1. the extent of the drink-driving problem
2. drink-driving enforcement levels
3. the expected installation rates

In general, we expect an AIP to perform better when the drink-driving problem is larger, and when the enforcement levels and the installation rates are higher. A DUI measure can more easily produce safety benefits when drink-driving presents a serious rather than moderate road safety problem. Relatively high enforcement levels contribute to better general prevention and higher installation rates. And finally, higher installation rates are important for enlarging the target group of the measure. If the USA figures are higher than the Irish figures on these three factors, then effect estimates for the USA may be thought too optimistic for Ireland. On the other hand, if Irish figures are higher than the USA figures on these conditions, we may expect the effect estimates for the USA to at least be equalled and probably improved upon by Ireland.

Table 3.2 presents information on some basic factors that may influence AIP effectiveness.

Table 3.2. Comparison USA and Ireland on factors that may influence AIP effectiveness

Domain	Indicator	Ireland	USA
Alcohol-related road safety problem	WHO 2018 status report alcohol: Alcohol-attributable percentages of road fatalities 2016	Males: 50.8% Female: 37.7%	Males: 42.5% Females: 25.0%
	WHO 2018 status report road safety: % road traffic deaths involving alcohol	39%	29%
Enforcement level to prevent drink-driving	Presence random breath testing	Yes	No
	BAC limit adult driver	0.05	0.08
	ESRA2: "*In the past 12 months*, how many times have you been checked by the police for using alcohol while driving a car (i.e., being subjected to a Breathalyser test)?"	Irish drivers: 22.5% checked at least once	USA drivers: 2.7% drivers checked at least once
	ESRA2: "On a typical journey, how likely is it that you (as a car driver) will be checked by the police for… alcohol, in other words, being subjected to a Breathalyser test?"	Irish drivers: 19.6% likely	USA drivers: 10.2% likely
Installation rate AIP	USA: installation rate per DUI convictions (Robertson et al., 2018).	Expected: 50-70%	2014: 35% 2015: 42% 2016: 47%

AIP can be assumed to be especially effective in countries with a serious DUI road safety problem. As the figures in *Table 3.2* show, both Ireland and the USA have a serious drink-driving problem. The figures appear to be higher in Ireland than in the USA. With perhaps a larger DUI problem in Ireland than in the USA, an AIP should not be expected to be less effective in Ireland than in the USA.

Another assumption was that high enforcement levels would support the effectiveness of the AIP program. According to the enforcement indicators in *Table 3.2*, Ireland has higher enforcement levels to prevent DUI than the USA, increasing the chances of AIP effectiveness for Ireland more than for the USA.

Finally, the installation rate of an AIP is an important condition for its effectiveness. Only in recent years, have the USA installation rates per DUI conviction tended to increase to about 47% (Robertson et al., 2018). The expected rates in Ireland are 50-70% and even considerably higher (65%-91%) if the interlock were completely financed by the state. In other words, the expected installation rate in Ireland is slightly over 25% higher than that in the USA (60% versus 47%) and even higher when fully financed by the state.

All in all, since Ireland has a DUI problem that is at least as serious and likely more serious than in the USA, has higher enforcement levels to prevent DUI, and has an expected installation rate that may be far above installation rates in past USA programs, it can be expected that an AIP in Ireland will have equal or probably greater safety effects than the USA estimates.

In light of the above, we have increased the expected road safety benefits from the best US study by a conservative 25% (factor 1.25) when applying the US safety estimate to the Irish situation. This 25% is specifically based on the expected differences in participation rates between alcohol interlock programs in the US and the proposed program in Ireland as stated in the paragraphs above, but this modest increase factor also seems quite plausible in view of the other differences between Ireland and the USA.

3.3.4 Best estimates

The expected safety benefits on alcohol-related fatal collisions can be derived from the following calculation. By introducing an AIP, the number of fatalities and injuries (see *Sections 2.2.1*, *2.2.2* and *2.2.3*) should be reduced by the estimated reduction factor published in the best studies, assuming this factor is also applicable to Ireland. In this chapter, the studies resulting in the best reduction factors have been described in *Section 3.3.2* and arguments have been provided as to whether the estimated reduction factor can also be generalised to the Irish situation (*Section 3.3.2*).

Table 3.3 presents the estimated road safety benefits of an AIP in two scenarios: 1. Costs of AIP installation covered by the driver, and 2. costs of AIP installation covered by the state. In the second scenario in which the government covers all costs, installation rates are expected to improve from 50-70% to 65-90% (see *Section 3.3.1*). Consequently, this would improve road safety benefits due to the AIP by a factor of approximately 1.3.

Table 3.3. Expected reductions in fatalities, serious road injuries and minor injuries due to AIP under two scenarios.

Crash outcome	**Estimated annual numbers *to be* reduced by AIP**	**Scenario 1 AIP costs covered by individual: 50% - 70% installation**	**Scenario 2 AIP costs fully covered by state: 65% - 90% installation**
Fatalities (F)	30	Reduction Range: Min CI: 1% * 1.25[a] = -1.25% equivalent to a reduction of 0.375 fatalities per year Max CI: 3% * 1.25 = - 3.75% (1.125 F)	Reduction range Min CI: 1.25 * 1.3[b] = -1.6% (0.48 F) Max CI: 3.75 *1.3 = - 5.0% (1.5 F)
Serious injuries (SI)	229	Reduction range Min CI: 1% * 1.25 = -1.25% (2.86 SI) Max CI: 3% * 1.25 = - 3.75% (8.59 SI)	Reduction range Min CI: 1.25 * 1.3 = -1.6% (3.66 SI) Max CI: 3.75 * 1.3 = -5.0% (11.458 SI)
Minor injuries (MI)	363	Reduction range Min CI: 1% * 1.25 = -1.25% (4.43MI) Max CI: 3% * 1.25 = - 3.75% (13.61 MI)	Reduction range Min CI: 1.25 * 1.3 = -1.6% (5.81 MI) Max CI: 3.75 * 1.3 = - 5.0% (18.15 MI)

[a] AIP is expected to perform better in Ireland than in the USA; therefore a 1.25 increase factor has been applied to the effects, to 95%-confidence intervals of the McGinty-2016 effect estimates (best study estimates).

[b]1.3 increase factor is applied in scenario 2 due to higher estimated installation rate (65-90% versus 50-70%).

3.4 Alternatives to the AIP

3.4.1 Licence suspension, licence withdrawal and fines

In most countries, licence suspension or withdrawal (in combination with a high fine) is the standard sanction for dealing with drink-driving violations. In a meta-analysis of different sanctions and measures for offenders, licence suspension was found to be the most effective intervention for both crashes and violations (Masten & Peck, 2004). Suspensions are generally decided upon in a court, making it difficult to separate the effects of suspension from the effects of the court appearance. However, mandatory licence suspensions are imposed for several reasons (e.g. DUI) and have been found to reduce crashes and violations, even though suspensions are frequently infringed.

Suspension or withdrawal of the driving licence is no guarantee that the suspended drivers do in fact no longer drive a car. Based on telephone interviews with 1000 drivers in Austria, for example, it was estimated that more than a quarter of the drivers whose driving licence had been suspended in 2012 continued to drive, and about 15% even continued to drive under the influence of alcohol (Raml, 2017). American and Australian studies (reviewed in Vis et al., 2010) indicate that 50-70% of the alcohol offenders continued to drive (occasionally), also after suspension or withdrawal of the licence. In a review on heavy alcohol offenders, Goldenbeld et al. (2016) conclude that traditional measures, such as fines and driving disqualifications, seem to have little or no effect on the group of serious alcohol offenders. At least 45% of the serious alcohol offenders are persistent in their violation behaviour and continue even after being apprehended by the police for driving under the influence.

The fact that many offenders continue to drive while their licence is suspended or revoked has been known for many years (e.g. Williams et al., 1984). This does not mean suspensions or withdrawals have no effect (at all) on the subsequent violation and crash rates.

3.4.2 Rehabilitation program

The main purpose of rehabilitation courses is to reduce recidivism with respect to drink-driving offences. Such a course is educationally or psychologically oriented, and typically organised in small groups. A comprehensive review of European (and non-European) rehabilitation programs for DUI offenders was done by Boets et al. (2008). With respect to European rehabilitation programs they found that these programs succeeded in reducing recidivism rates in a range from 15.4% up to 71.9%. Taking the available reduction rates into account (N=15), the average reduction rate was 45.5% (Boets et al., 2008).

Slootmans et al. (2017) reviewed outcomes of recent DUI rehabilitation studies. The main outcome variable in these studies was recidivism for ‘driving under the influence of alcohol’ (DUI) in the 2 to 3 years following the course. Participants were compared to non-participants (e.g. DUI-offenders who were given a more traditional sentence such as a prison sentence). The results indicate that rehabilitation courses for DUI-offenders can reduce recidivism by 40% and thus have a positive effect on road safety. The authors identified an important course characteristic: a focus on behavioural change (i.e. a concrete plan of what to do when a relapse is imminent) rather than simply providing information. Furthermore, the course should be spread over at least several weeks. The recent recidivism reduction estimate for rehabilitation courses is a fairly good result but it is still considerably less than the best estimate for an alcohol interlock: in a meta-analysis, Elder et al. (2011) estimated that installing an alcohol interlock reduces recidivism risk by 75% (compared to the standard sanction, primarily licence suspension).

3.4.3 Imprisonment

Long-term imprisonment is effective in keeping offenders off the roads, thus preventing further offences. However, such a policy comes with very high economic costs. For Europe, the average costs of housing an inmate are €283.58 per day, and the Irish system requires about €189 to house an adult prisoner each day (Aebi et al., 2016). That means very high costs for 2 or more years of imprisonment. In comparison, the costs of an AIP program for 2 years are 5 to 8 times lower. Apart from the economic considerations, moral arguments may come into play. Why would long-term imprisonment not be a suitable measure in some drink-driving violation cases where irresponsibility, reckless behaviour and obvious disregard for the well-being of others are proven without doubt? In such cases, long-term imprisonment may indeed be the best measure from a viewpoint of meting out justice and protecting society.

3.4.4 Monitoring

An alternative to controlling the driving of DUI offenders is to control their drinking (Fell, 2019). This can be done by the use of transdermal alcohol-monitoring (TAM) devices or by regular analysis of biomarkers (Fell, 2019). TAM is a technology that permits the detection of drinking by sensing alcohol that passes through the skin as it is eliminated from the body (McKnight et al., 2012). As part of an overall monitoring system, these alcohol measurements are sent from the transdermal monitoring device to officials who supervise the offender. A method for monitoring drinking that is more widely used in Europe is to analyse the biomarkers in blood, urine, or hair that result from the consumption of alcohol (Fell, 2019). In contrast to the interlock, the available TAM technology cannot prevent people from driving after drinking alcohol, even when it can be further developed to actually detect (potential) driving after alcohol consumption.

In the USA, TAM devices are increasingly used on offenders having committed alcohol-related crimes (McKnight et al., 2012). In case studies, it has been established that transdermal alcohol monitoring reliably monitors alcohol use by offenders and that transdermal monitoring devices appear not to present any insurmountable practical problems. However, costs are an issue. McKnight et al. (2012) mention costs of $5 to $12 a day for the use of this technology, and they note that that the costs for other technologies - $2.25 to $2.75 a day for ignition interlocks – are significantly lower. Therefore, the costs of transdermal monitoring preclude its use.

Fell (2019) observes that transdermal alcohol monitoring is useful as an alternative to an interlock for a specific group of offenders: “An alternative to the interlock program is needed for those offenders without cars or who are willing to take the risk of driving illicitly rather than installing the interlock, because experience shows that offenders do continue to drive and become involved in crashes. Monitoring offenders’ BACs appears to be an effective alternative to the interlock” (Fell, 2019, p. 176). In a Canadian study (Averill et al., 2019), a majority of participants perceived the TAM device used as precise and acceptable to their social environment, and participants also indicated that the device contributed to a reduction in their drinking. 12% agreed or strongly agreed that wearing the device was generally inconvenient, and most participants reported some inconveniences related to specific situations (swimming, playing hockey, sleeping, high temperatures).

Fell (2019) also remarks on the possible interplay between different legal programs. He writes: “On the horizon is a developing technology that detects driving via an ankle bracelet with accelerometers that measure the foot movements required to operate a vehicle. When perfected, this will allow the court to monitor offenders to ensure they are not driving. This could be offered as an alternative to the interlock. Programs need to be created that require electronically monitored abstinence or electronically monitored driving as alternatives to the interlock. More offenders will then decide to choose the interlock instead of the other more stringent alternatives.”(Fell, 2019, p. 176).

3.4.5 Conclusion

None of the considered alternatives for the alcohol interlock measure – licence suspension, rehabilitation, imprisonment, monitoring - has shown comparable cost-effective performance in reducing drink-driving among repeat offenders. Individually, licence suspension, rehabilitation and monitoring measures cannot reduce recidivism to the same degree as the alcohol interlock. Imprisonment does reduce recidivism but at disproportional economic costs. Although all these alternative measures exist for good reasons, for a large group of serious alcohol offenders they are less effective than a well-organised alcohol interlock program.

4 Methodology and data

Here, the method (*Section 4.1*) to determine costs, benefits and (net present) value of an AIP is described. It consists of the baseline ("change nothing"), the intervention, the appraisal period and relevant costs and benefits. The second section (*Section 4.2*) describes the data that are used, such as implementation costs or monetary value of a (statistical) life saved. The last section (*Section 4.3*) deals with the sensitivity analyses, i.e. the impact of varying input values on the outcome (BCR and NPV).

4.1 Methodology

4.1.1 Baseline and policy intervention scenario

In a CBA, the costs of a policy intervention are determined relative to a baseline scenario. In this case, the intervention is the introduction of an AIP for repeat drink-drivers as described in *Sections 3.1* and *3.2.* The objective of this intervention is to:

- Prevent repeat drink-drivers from drinking and driving
- Reduce the number of collisions involving repeat drink-drivers.

In general, the baseline scenario represents what would occur in the absence of the proposed intervention. This is often referred to as business-as-usual and should as much as possible accurately reflect the likely course of action in the absence of any change in policy. In this case, the baseline scenario is the situation without introduction of an AIP and continuation of current policy. Current policy is driving licence withdrawal for repeat drink-drivers. The minimum disqualification period for a repeat drink-driver varies from 0.5 to 6 years, depending on BAC levels (Citizens Information, 2020). However, judges have discretion to raise or decrease penalties. For this CBA, the disqualification period is assumed to be 2 years on average.

4.1.2 Appraisal period

The CBA is applied assuming the alcohol interlock program will run for 10 years. It is assumed that the AIP will be introduced in 2021 and will run until the end of 2030. All costs and benefits in this period are included in the CBA and costs and benefits that occur in the future are discounted to present values. The 4% discount rate that has been set by the Department of Public Expenditure & Reform in the Public Spending Code (DPER, 2019) is applied. The base year is 2018 and the 2018 price level is applied to all costs and benefits..

Note that transport projects often have impacts over a long time period. Infrastructure projects, for example, usually have significant up-front costs that must be compared against benefits that accrue over a longer period. Therefore, the Strategic Research and Analysis Division (SRAD) recommends a CBA that typically forecasts future costs and benefits over a long time horizon. In Ireland, the official transport-specific evaluation period is 30 years (DTTaS, 2016). However, in the case of the introduction of an AIP, the magnitude of the initial investment will be significantly less than that of typical projects to develop road or public transport infrastructure. For example, the initial investments for the AIP are estimated at about €1.8 million (see *Section 4.2.1*), while the costs of projects such as (re)constructing or maintaining road infrastructure are much higher. Therefore, a shorter time horizon (10 years) is more adequate. Moreover, it is unclear for how many years the AIP will run and using a longer time horizon will unnecessarily introduce more uncertainties.

4.1.3 Costs

The costs of introducing the AIP consist of the additional costs related to the intervention relative to current policy. Consequently, the difference between the costs of introducing the AIP and the costs of current policy needs to be determined for the CBA. This implies, for example, that enforcement costs are not included in the CBA assuming the introduction of the AIP does not affect enforcement activities.

Three groups of costs can be distinguished:

1. Current costs that remain unchanged, which include costs of:
   - Drink-driving enforcement
   - Public campaigns
   - Education
   - Administration related to penalty point registration and fines administration
   - Courts
   - Imprisonment
2. Current costs that will be eliminated:
   - Administrative costs related to withdrawing/returning driving licence and the related registration
3. Costs of the AIP, which include the costs of:
   - Implementation (new legislation and regulation, organisational changes)
   - Administrative costs (driving licence adaption, compliance supervision, accreditation suppliers/installers, etc.)
   - Purchase/rent of the alcolock devices
   - Installation and removal of the alcolocks
   - Data download and analysis.

In the CBA, the costs and benefits of introducing the AIP are assessed as compared to the current situation. Consequently, only the costs of the AIP and the current costs that will be eliminated are relevant for the CBA. Current costs that remain unchanged are not part of the CBA.

4.1.4 Safety benefits

The advantages of introducing the AIP from a road safety perspective include:

- Prevention of driving under the influence by repeat drink-drivers
- Reduction in number of collisions caused by repeat drink-drivers
- The avoided fatal, serious and minor injuries which would have occurred as a result of drink-driving by a repeat offender.

To calculate the monetary safety benefits, the annual number of avoided fatal, serious and minor injuries in the appraisal period are multiplied by the monetary valuations per casualty. This requires an estimation of the expected number of road casualties in future years (2018-2030). For the present CBA, the number of casualties is determined using a local linear trend model (see *Section 4.2.2* for further details). Two alternative scenarios are included in the sensitivity analysis. The first alternative scenario assumes a decrease in the number of fatalities and serious injuries that would be needed to achieve EU targets, which is a 50% decrease in the number of fatalities and serious injuries as compared to 2020. The second alternative scenario assumes that the number of casualties remains stable at the 2018 level.

The annual number of avoided casualties is obtained by multiplying the number of casualties by the reduction percentages shown in *Table 3.3*. Next, the annual monetary benefits are calculated by multiplying the number of avoided casualties by the monetary valuation per casualty. Total safety benefits are the sum of the discounted annual benefits.

The monetary valuation of preventing road casualties consist of costs savings related to road crashes. According to international standards, the socio-economic costs of road crashes include six main cost elements (Wijnen et al., 2019):
1. Medical costs, such as ambulance, hospital and rehabilitation costs;
2. Production loss: lost productive capacity of road casualties;
3. Human costs: the intangible costs of loss of quality of life and life years;
4. Property damage, particularly vehicle damage;
5. Administrative costs: police, fire service, insurance, legal costs;
6. Other costs, such as funeral costs, congestion costs and costs of vehicle unavailability.

The monetary valuations per avoided casualty include injury-related costs (medical costs, production loss and human costs) as well as crash-related costs (police costs, property damage and administrative costs). Crash-related costs are converted to costs per avoided casualty using the number of casualties per crash.

4.1.5 Mobility benefits

In addition to safety benefits, a key benefit for the participants taking part in the AIP is the increased mobility benefits, as they are then permitted to drive with an alcohol interlock fitted as opposed to being disqualified from driving. For the mobility benefits calculation, we follow the 'generalised costs approach' that was applied in cost-benefit analyses of impairment countermeasures conducted in the European project 'IMMORTAL' (Vlakveld et al., 2005). The generalised costs are the total costs of travelling which include vehicle operating costs (private transport), ticket costs (public transport) and time costs. This approach assumes that mobility benefits, such as opportunities to access jobs and education and take part in social and recreational activities, may not be equal for each transport mode. Also differences in, for example, the comfort of travelling are not included. Consequently, the benefits of an AIP only consist of the difference in generalised costs between driving and alternative transport modes. In addition, the loss of mobility benefits for people who cancel trips due to driver licence withdrawal is taken into account.

Figure 4.1 illustrates the approach. The curve shows the demand function for travelling: the number of trips increases if the costs of travelling decline. Area A represents the benefits if people can continue to drive instead of using another transport mode. This area is calculated by multiplying the number of trips people would have made without the AIP using another transport mode by the cost difference of driving and the other transport mode.[7] To calculate these benefits, information on the change in modal shift due to current policy (licence withdrawal) is needed. Using this information, area A can be calculated for each transport mode.
In addition, some people might have chosen to cancel trips if their driving licence had been withdrawn. Their mobility benefits resulting from the AIP are represented by area B. For some people (at the left side of area B) the benefits are just below the cost difference between driving and an alternative transport mode, while for other people (at the right side of area B) the benefits are much lower.8 Here the 'rule of half' is applied: the benefits are calculated by multiplying the

7 Note that the generalised costs of other transport modes must be higher than the costs of driving, because otherwise people would always have chosen the alternative transport mode (with or without AIP; assuming that other mobility benefits are the same for all transport modes).

8 Note that the mobility benefits for this group cannot be higher than the cost difference between driving and the alternative mode, because otherwise they would not have chosen to cancel the trip.

number of trips that would have been cancelled without the AIP times half of the (average) cost difference between driving and other modes.

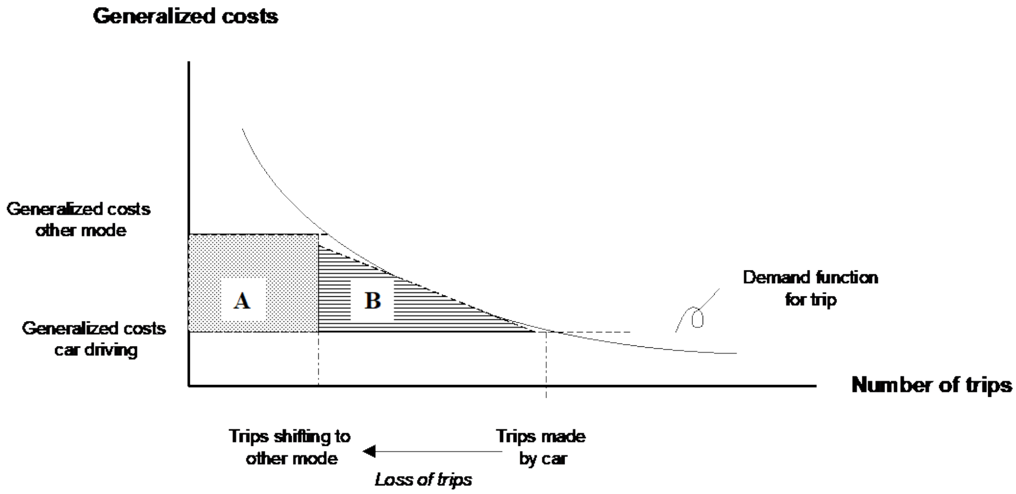


Figure 4.1. Generalised cost approach for estimating mobility benefits. Source: Vlakveld et al. (2005

4.1.6 Cost-effectiveness

The final results of the CBA are the net present value (NPV) and the benefit cost ratio (BCR). The net present value is calculated as the sum of the discounted benefits in the appraisal period minus the sum of the discounted costs. The BCR is the sum of the discounted benefits divided by the sum of the discounted costs. A positive NPV or a BCR greater than 1 indicates that the introduction of the AIP is cost-effective.

4.2 Data

4.2.1 Costs

Table 4.1 shows estimates of costs borne by participants for AIPs in various countries.

For this report, the costs outlined in the Dutch AIP (Gouweleeuw, 2014) will be used, as they are the most recent and detailed figures available for an AIP. These costs are in line with the overall costs for both Finland and Sweden (all 3 countries had a two-year AIP, which is assumed to be the same for Ireland). These costs include installation, data downloads, administrative costs and monitoring and support costs. Per participant, the costs are €3,829 in 2018 prices (using the consumer price index from CSO) and taking into account discounting of the costs in the second year (4%, source: TTI, 2019). For the sensitivity analysis, the lowest and highest estimates are used (€2,850 and €5,700 respectively).

In addition, there are costs associated with the time participants spend on installation of the device and on data downloads that take place regularly and in case of attempts to start the car with a raised blood alcohol content (BAC) level. We assume that, together, this will take 18 hours in a two-year period: for installation: two hours; quarterly data downloads: two hours each. Using a value of €27 per hour in 2011 prices (AECOM, 2019), the time costs per participant are €746 in 2018 prices (using Gross National Income per person employed to account for inflation and real income growth and taking into account discounting).

Table 4.1. The costs of alcohol interlock programs in different countries, what is included in the costs and the source of the data

Country	Costs borne by participant	Source
Netherlands	Approximately: €3,790 for 2 years. This includes: › Administrative costs and monitoring and support › Installation › Data downloads (depends on the behaviour of the participant)	RDW: *Dutch Alcohol Interlock Program* (Gouweleeuw, 2014)
Sweden	Approximately €2,850 - €4,150 for 2 years	The Swedish Transport Agency: *The Swedish Transport Agency and our work with an alcohol interlock program* (Skarviken, 2016)
Finland	Approximately: €3,650 for 2 years (i.e. €5 per day) › Alcohol interlock device + installation and removal, €1250 - 1500 › One visit to a doctor/health care professional, public: €30/private: up to €160 › Inspection of the vehicle after installation and removal of interlock €40/€60 › New driving licence, €30 › Data read out every 60 days, €20 - €60 › Calibration (usually once a year) €30 - €60 › Removal €100 - €170	Trafi Finnish Transport Safety Agency: *Feedback and analysis of Finnish legislation and interlock rehabilitation program for offenders and recidivists* (Löytty, 2016)
Austria	Approximately: €5,700 for 2 years. This includes: › €200 per month (rental of the device) › €150 per hour (minimum of 4 hours) for the mentor › €300 for the installation and the removal of device	Kuratorium für Verkehrssicher-heit KfV, Vienna: *Alternative Probation System (APS) in Austria* (Kaltenegger, 2017)

Regarding the administration costs associated with implementing an AIP, there is limited information available. RSA have consulted with the Swedish Transport Agency which found that the setting-up costs for putting the AIP into place in Sweden were approximately 15 million SEK, price level 2011. The Swedish costs will be used for Ireland as an estimate of likely administrative costs to set up and implement the AIP. The costs are €1.4 million at price level 2018 (using consumer price index from CSO and purchasing power parities from World Bank, 2019).

Furthermore, there are administrative costs of the National Driver Licence Service (NDLS), which is the main organisation involved in the administration of driver licence withdrawal (current policy) as well as costs related to recording disqualifications in the National Vehicle Driver File (NVDF) maintained by the Department of Transport, Tourism and Sport. These costs of current policy are treated as negative costs (cost savings) in the CBA. However, evidence from the USA indicates that these costs are relatively low compared to the other cost items (AAMVA, 2018): data from two states show that less than half an hour is spent per suspension and fixed costs are only 0.25 USD per suspension. Therefore, these costs are assumed to be negligible.

Following the Common Appraisal Framework (DTTaS, 2016), all costs borne by the government are multiplied by 1.3 (1.3 * 1.4 = 1.8) to account for economic distortions that result from taxes.

Table 4.2 summarises the costs relevant to the CBA. Note that the administrative costs of the AIP are higher if the costs are borne by the government in scenario 2, due to the 1.3 factor that is applied to public expenditure.

Table 4.2. Costs of the AIP

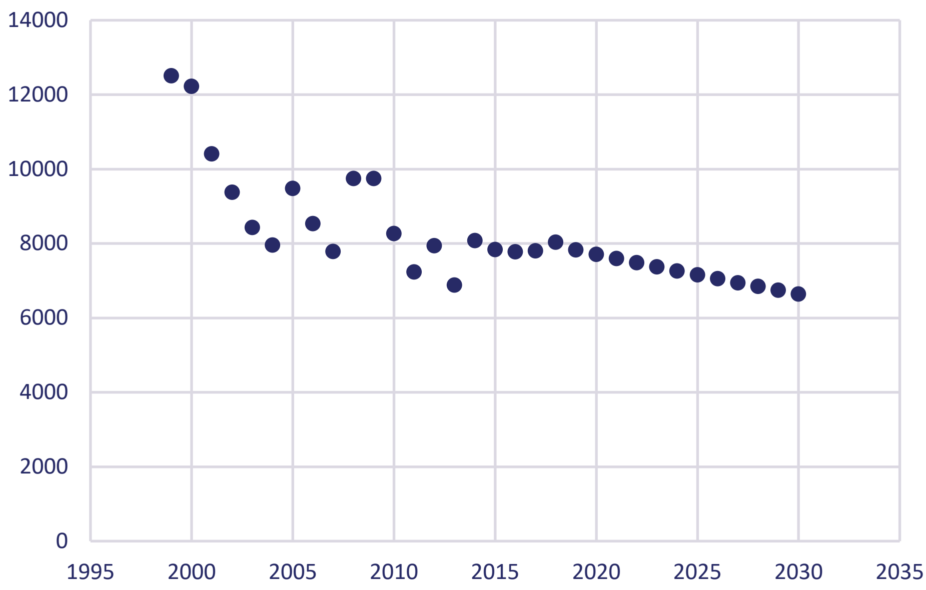
Cost item	Amount	
	Scenario 1	Scenario 2
Implementation costs	€1.8 million	€1.8 million
Administrative costs AIP per participant	€3,829	€4,978
Time costs per participant	€732	€732

4.2.2 Number of prevented casualties

As explained in *Section 4.1.4*, an estimation of the expected number of casualties in the appraisal period is needed for the calculation of safety benefits. In the base case, the number of fatalities, serious injuries and minor injuries 2018-2030 is estimated on the basis of the development of the number of fatalities and (all) injuries in the period 1999-2018. Both series were analysed with a local linear trend model, the fatalities in their logarithm and the seriously injured as absolute counts, see Commandeur & Koopman (2007). A forecast of the total number of injuries is used to the year 2030. To estimate the number of serious and slight injuries in 2019-2030, the ratio of the number of serious and slight injuries is assumed to be constant and equal to the ratio in 2018. This method is used because there has been an increase in the number of serious injuries reported in police data since 2014. The increase is likely due to a change in the way data on collisions were received by RSA from the police. Using historic trend data of serious injury numbers from 1999 to 2018 as the base to estimate serious injury figures to 2030 is therefore not possible. This is because 2014 is considered as a break in the time series for the data on serious injury numbers. *Figure 4.2* and *Figure 4.3* show the actual number of fatalities and injuries for 1999-2018 and the estimated numbers for 2019-2030. The number of fatalities and injuries are assumed to have decreased to 71 and 6,642 respectively by 2030. Using a fixed ratio of serious and minor injuries, this translates into 1,110 serious injuries and 5,533 slight injuries.

Figure 4.2. Actual number of fatalities 1999-2018 and forecast 2019-2030

Figure 4.3. Number of injuries 1999-2018 and forecast 2019-2030



In the sensitivity analysis two alternative scenarios are applied:

- A decrease in the number of fatalities and serious injuries needed to achieve the EU targets, which is a 50% decrease in the number of fatalities and serious injuries as compared to 2020. Minor injuries decrease at the same rate as in the base case.
- A stable number of fatalities, serious injuries and minor injuries at the 2018 level: 156, 1,047 and 6,745 respectively.[9]

The EU targets imply that, in 2030,the number of fatalities and serious injuries should not exceed 63 and 644 respectively. These numbers are determined by halving the expected number of fatalities and serious injuries in 2020 as determined in the base case (125 and 1,288 respectively). A linear decrease between 2018 to 2030 is assumed, which means that the number of fatalities decreases by 6 each year and the number of serious injuries by 58. In this scenario, the number of serious injuries declines much stronger than in the base case, while the decrease of the number of fatalities is just slightly stronger.

4.2.3 Monetary valuation safety benefits

Table 4.3 shows the costs per casualty or per crash by severity in Ireland as included in the Common Appraisal Framework (DTTaS, 2016). These costs are methodologically in line with international standards, particularly since the internationally recommended 'willingness to pay' approach is applied to estimate human costs (Wijnen et al., 2019). However, congestion costs are missing. These costs are estimated at roughly €20-50 million (price level 2014), which is 3-7% of total road crash costs in Ireland (Wijnen, forthcoming).

9 These figures are provisional but were correct at time of calculation.

Table 4.3. Values of prevention of road casualties and crashes by severity and cost element, € (price level 2011). Source: DTTaS (2016).

Severity	Injury-related			Crash-related			Total
	Lost output	Human costs	Medical costs	Police costs	Property damage	Insurance and administration	
Fatality	701,881	1,338,656	1,205	21,521	13,952	375	2,077,589
Serious injury	27,041	186,012	16,382	2,519	6,225	233	238,412
Slight injury	2,858	13,617	1,212	653	3,713	142	22,053
Property-damage-only crash	-	-	-	42	2,346	67	2,456

Three modifications are made to the figures in *Table 4.3*:

1. The costs per casualty are raised by a factor 1.05 to account for the missing congestion costs, based on Wijnen (forthcoming), as discussed above.
2. In addition, the costs per slight injury are raised by a factor 1.4 to account for the fact that the AIP may also have an impact on property-damage-only crashes. This factor is based on the total costs related to property-damage-only crashes and slight injuries which are €60 billion and €162 billion respectively (RSA, 2013b). This approach assumes that PDO crashes are prevented proportionally to the number of slight injuries prevented.
3. Indexation for inflation and real income growth is applied, using nominal Gross National Income per person employed (source: CSO) as recommended in the Common Appraisal Framework (DTTaS, 2016).

The resulting values per prevented casualty are (2018 prices):

- Fatality: €3,349,082
- Serious injury: €384,321
- Slight injury (including PDO): € 48,716

4.2.4 Mobility impacts

The calculation of mobility benefits is based on differences in generalised costs (vehicle operating costs and time costs) between car and alternative transport modes and the change in modal shift due to the fact participants can continue to drive instead of using alternative transport modes. Following Irish transport statistics, we distinguish between travelling as a car passenger, travelling by bus or rail (train, tram), and cycling or walking, which are assumed to be the most relevant transport modes. *Table 4.4* presents the generalised costs by transport mode.

Table 4.4. Generalised costs by transport mode (Euro 2018)

Mode	Vehicle operating costs	Time costs	Total
Car	0.18	1.0	1.2
Bus	0.11	2.3	2.4
Train/tram	0.13	2.1	2.3
Cycle	0	3.4	3.4
Walk	0	7.8	7.8

The source of the vehicle operating costs is DTTaS (2016) which updated to 2018 prices using CPI (source: CSO). Time costs are calculated using average speed per transport mode and the value of time of car drivers. The average speed is based on data from the National Travel Survey 2017 on average distance and duration per journey by transport mode (source: personal communication with the National Transport Authority). The duration includes in-vehicle time as well as other time such as waiting time and transfer time in public transport. *Table 4.5* shows the average speed by transport mode. The value of time for car drivers was €27 per hour in 2011 (DTTaS, 2016). This translates into €41 per hour in 2018, taking into account inflation and real income growth on the basis of nominal Gross National Income per person employed (source: CSO), following the Common Appraisal Framework (DTTaS, 2016).

Table 4.5. Average speed by transport mode

Mode	Average speed (km/h)
Car	39
Bus	19
Train/tram	18
Cycle	12
Walk	5

Table 4.6 shows the assumed distribution of the distance travelled by alternative transport modes if convicted drivers lose their driver licence, including the option that a driver cancels journeys. This distribution is based on several sources on distance travelled by transport mode, in particular:

- The proportional distribution of total annual passenger kilometers by car, bus and rail from Eurostat (82.6%, 14.3% and 3.1% respectively in 2017).
- The distribution of the number of journeys over transport modes (*Table 4.7*, Source: CSO)
- Average journey length by transport mode from the National Travel Survey (*Table 4.7*, source: personal communication with the National Transport Authority).

Table 4.6. Distribution of distance travelled by alternative transport modes after losing driving licence

Mode	Proportion distance travelled
Car passenger	20%
Bus	45%
Train/tram	15%
Cycle	5%
Walk	5%
No travel	10%

Table 4.7. Distribution of number of journeys (source: CSO) and average journey length (source: NTA)

Mode	Distribution number of journeys	Average journey length (km)
Private car - Driver	69.4%	23.6
Private car - Passenger	4.9%	16.9
Walk	14.6%	1.6
Bus	4.2%	7.3
Cycle	1.7%	4.4
Train/tram	1.3%	8.5
Taxi/hackney	0.8%	-
Lorry/Motorcycle/Other	3.2%	-
Total	100%	

The mobility benefits are calculated using the difference between the weighted average generalised costs of alternative transport modes and the generalised costs of driving a car. The generalised costs of alternative transport modes are weighed by the proportion of distance travelled (*Table 4.6*). The resulting cost difference is €1.0 per kilometer. To calculate areas A and B in *Figure 4.1*, this cost difference is multiplied by the average mileage of car drivers. The average mileage is 12,374 km per driver (distance travelled by private cars (35,975 in 2018)) divided by the number of driver licences (2,907,192 in 2018), source: CSO). Concerning the journeys that would have been cancelled under current policy, the 'rule of half' is applied (see *Section 4.1.5*). The resulting mobility benefit costs per participant are €22,977, taking into account that the benefits occur in a period of two years (including a 4% discount rate for the benefits in the second year).

Note that under current policy, people may continue driving even though their driver licence has been withdrawn. For instance, research from the Netherlands shows that about 50% to 70% of car drivers still use their cars after driver licence withdrawal (Vis et al., 2010). This would imply that the mobility benefits are lower than calculated above. However, the mobility benefits of driving a car without a driver licence under current policy are gained by violating the law. In the literature on cost benefit analysis, it is generally recommended to exclude such benefits (see for example Elvik, 2006). The sensitivity analysis includes a scenario where drivers whose licence has been revoked keep on using their cars for 50% of their usual distance travelled under current policy.

4.3 Sensitivity analysis

The base calculations for the benefit cost ratio comprise both AIP implementation scenarios: that of the case when costs are fully borne by program participants and that when the costs of the program are fully borne by the state. Calculations for both scenarios were performed with low (neutral) and high (optimistic) input values for the reduction effect of the AIP on the number of casualties.

The number of input parameters and their range of possible values limit the possibilities to make all calculations in a spreadsheet workbook. To assess the effect of all major input parameters and their interaction, the BCR-calculation-model was rebuilt as an R program using basic R libraries. This program makes it possible to vary all selected input parameters within their designated range. The variation could be a generated random number within the possible range. At the same time, it was possible to set other parameters to a fixed value. The resulting model with variable and fixed input variables was put in program loop to generate 10,000 results for a particular input configuration. The use of this loop in combination with randomised input parameters enables the calculation of statistical parameters like mean, standard deviation and extremes for an input configuration. Fixing some of the parameters while varying others, made it possible to focus on particular interactions between input parameters.

5 Results

The outcome of this study is presented here for different implementation and effectiveness scenarios (*Section 5.1*) and for different casualty development scenarios (*Section 5.2*), including a most likely scenario. Results include both the benefit cost ratio (BCR) and the net present value (NPV). The sensitivity analyses in *Section 5.3* show the sensitivity of these outcome parameters in relation to variations in several input variables.

5.1 Findings

The basic benefit-cost-ratio (BCR) calculations were made for two scenarios: costs fully paid by the AIP participants (scenario 1) or cost fully paid by the state (scenario 2). These scenarios were calculated both for a low (1.25%) and a high (3.75%) reduction rate of injuries as a result of the AIP (see *Section 3.3.4*). The assumption for these scenarios is that the number of road casualties will decrease in time as a result of government measures (casualty development scenario b). To estimate this decrease, SWOV produced a value for fatalities and the total number of injuries based on the time series for the variables between 1999 and 2018. The number of serious and minor injuries were derived from these predictions, based on the 2018 ratios between the total number of injuries and the number of serious injuries in that year (see *Section 4.2.2* for more details).

Table 5.1. Benefits and costs of the AIP base scenarios

Incremental benefits and costs (€) over the appraisal period of 2021-2030				
Scenario	**Scenario 1, low reduction range**	**Scenario 1, high reduction range**	**Scenario 2, low reduction range**	**Scenario 2, high reduction range**
Casualty development scenario	b	b	b	b
Implementation costs	1,826,230	1,826,230	1,826,230	1,826,230
Costs of the AIP	8,586,079	8,586,079	13,978,706	13,978,706
Safety benefits (fatalities avoided)	6,335,541	19,006,622	8,236,203	24,708,609
Safety benefits (serious Injuries avoided)	7,335,682	22,007,047	9,536,387	28,609,161
Safety benefits (Minor injuries avoided)	1,473,972	4,421,917	1,916,164	5,748,493
Mobility benefits	43,254,185	43,254,185	56,250,217	56,250,217

'Implementation costs' include the costs of setting up the AIP and the 'Costs of the AIP' are the costs per participant such as installation, administrative costs, and time costs. Costs related to market distortions because of government expenditure are included, which results in higher costs in scenario 2 in which the costs of the AIP are borne by the government (in addition to implementation costs), see *Section 4.1.2*. Safety benefits are the avoided costs related to casualties prevented, which are calculated using the number of casualties prevented and the costs per casualty (see *Section 4.2.2*). Logically, safety benefits are higher in the scenarios with higher reduction rates and higher participation rates. Mobility benefits relate to the fact that drivers can continue to drive under the AIP as opposed to the baseline scenario (driver licence withdrawal). These are calculated on the basis of the cost difference between driving and alternative transport modes including time costs (see *Section 4.2.3*). These benefits are higher in scenario 2 due to the higher participation rates related to the fact that the government pays the costs per participant in this scenario.

As can be expected, a higher reduction rate leads to a higher benefit cost ratio and better net present values. Scenario 1, in which the costs are fully borne by the AIP participants leads to both higher BCR but lower net present values. Scenario 2 has the additional benefit of a higher number of participants in the AIP program.

Table 5.2. Summary of the results of the total incremental benefits and costs for the base scenarios and the resulting Benefit Cost Ratio and Net Present Value

Overall summary of benefits and costs (€) over the appraisal period of 2021-2030				
Scenario	**Scenario 1, low reduction range**	**Scenario 1, high reduction range**	**Scenario 2, low reduction range**	**Scenario 2, high reduction range**
Present value of total benefits	58,399,655	88,690,060	75,939,328	115,316,855
Present value of total costs	10,412,462	10,412,462	15,804,622	15,804,622
Net present value (NPV)	47,987,193	78,277,598	60,134,706	99,512,232
BCR	**5.6**	**8.5**	**4.8**	**7.3**

5.2 Alternate scenarios for the future development of the number of road casualties

The main scenario for the future development of the number of casualties in road collisions is described in *Section 5.1*. This scenario assumes that government intervention will gradually result in lower numbers of casualties and therefore reduce the scale of the impact of the alcohol interlock program. This assumption reflects the expected development in casualties during the next ten years. It is however an approximation, and therefore two other future development scenarios were examined: (a) the number of casualties remaining at the 2018 level during the entire program period and (c) the number of casualties following the pathway to reach the EU targets for 2030, reducing the number of road fatalities and injuries by 50% as compared to 2020 (see *Section 4.2.2* for more details).

Table 5.3 and *Table 5.4* present the results for these two alternate casualty development scenarios. The scenario with a constant number of casualties (scenario a) over the appraisal period results in a higher BCR and NPV than the base development scenario. The development scenario that assumes a casualty development to meet the EU targets (scenario c) has a lower yield in terms of BCR and NPV, as the number of casualties declines faster than that in the base development scenario.

Table 5.3. Benefits, costs and resulting BCR and NPV for alternate casualty development scenario a

Incremental benefits and costs (€) for alternate development scenario a: the number of casualties remains at the 2018 level over the appraisal period of 2021-2030

Scenario	Scenario 1, low reduction range	Scenario 1, high reduction range	Scenario 2, low reduction range	Scenario 2, high reduction range
Implementation Costs	1,826,230	1,826,230	1,826,230	1,826,230
Costs of the AIP	8,586,079	8,586,079	13,978,706	13,978,706
Safety benefits (fatalities avoided)	9,418,011	28,254,033	12,243,414	36,730,243
Safety benefits (serious Injuries avoided)	8,249,768	24,749,305	10,724,699	32,174,097
Safety benefits (minor injuries avoided)	1,657,641	4,972,922	2,154,933	6,464,799
Mobility benefits	43,254,185	43,254,185	56,250,217	56,250,217
Net present value (NPV)	52,167,296	90,818,136	65,568,326	115,814,418
BCR	6.0	9.7	5.1	8.3

Table 5.4. Benefits, costs and resulting BCR and NPV for alternate casualty development scenario c

Incremental benefits and costs (€) for alternate development scenario c: the number of casualties follows the pathway to reach the EU targets in 2030 over the appraisal period of 2021-2030

Scenario	Scenario 1, low reduction range	Scenario 1, high reduction range	Scenario 2, low reduction range	Scenario 2, high reduction range
Implementation costs	1,826,230	1,826,230	1,826,230	1,826,230
Costs of the AIP	8,586,079	8,586,079	13,978,706	13,978,706
Safety benefits (fatalities avoided)	6,038,233	18,114,700	7,849,703	23,549,110
Safety benefits (serious Injuries avoided)	5,289,230	15,867,690	6,875,999	20,627,997
Safety benefits (minor injuries avoided)	1,062,774	3,188,323	1,381,607	4,144,820
Mobility benefits	43,254,185	43,254,185	56,250,217	56,250,217
Net present value (NPV)	45,232,114	70,012,590	56,552,590	88,767,209
BCR	5.3	7.7	4.6	6.6

The predicted number of casualties in development scenario b also provided the 68% confidence interval values for the fatalities and total number of injuries. It was assumed that the serious and minor injuries follow the same pattern as the total number of injuries. Based on these assumptions, the BCR and NPV were also calculated for the left and right values of this confidence interval. *Table 5.5* shows the resulting BCR and NPV values.

Table 5.5. Results for casualty development scenario b (Mean) and its 68% confidence interval

Future development scenario b: BCR and NPV for the 68% confidence interval (€) over the appraisal period of 2021-2030				
Scenario	**Scenario 1, low reduction range**	**Scenario 1, high reduction range**	**Scenario 2, low reduction range**	**Scenario 2, high reduction range**
Mean BCR	5.6	8.5	4.8	7.3
Lower conf. interval. BCR	5.2	7.3	4.5	6.3
Higher conf. interval BCR	6.2	10.1	5.3	8.7
Mean net present value	47,987,071	78,277,462	60,134,035	99,511,543
Lower conf. interval. NPV	43,898,873	66,012,869	54,819,378	83,567,572
Higher conf. interval NPV	53,629,120	95,203,609	67,468,698	121,515,534

Both BCR and NPV clearly remain within a positive range. The lower interval still has acceptable values of both output parameters for all four base case (b) scenarios.

The most likely implementation of the AIP will be a version where the participants pay the full cost of the program (scenario 1), as this is common practice in other countries. We expect the values for both the installation rate and the reduction range to be somewhere between the lowest and highest values that were used to produce *Table 5.1*. Implementation costs as well as mobility benefits are expected to differ little from the estimations used to calculate scenario 1. The development of the number of casualties will most likely follow a path similar to the predicted number in development scenario 2, a gradual decline during the appraisal period. The input values and resulting BCR and NPV are shown in *Table 5.6*.

Table 5.6. Parameters, benefits and costs of the most likely (base) case AIP

Scenario	**1**	
Casualty development scenario	b	Estimate, gradual decline in the number of casualties
Installation rate	60%	
reduction range	2.5%	
Mobility benefits	22,977	per 2 years pp
Implementation costs	1,826,230	Total
Number of participants	2,521	
BCR	7.1	
Net present value	63,132,267	Euro total

5.3 Sensitivity analysis

The impact of the input parameters on BCR and NPV was assessed in more depth in a sensitivity analysis. The analysis was done separately for both scenarios. This was done because the way the program is financed imposes rules on several input parameters that cannot be changed. In practice, such a mixed model, in which both participants and the state pay part of the program costs, is possible but more details about this model would be needed to make accurate estimations of the resulting costs and benefits.

The main analysis was performed by using the casualty development estimate (scenario b) for the number of casualties during the appraisal period. Scenario 1, full payments of the program by the participants, was used as a base case but within this case, several combinations of input parameters will result in a wide range of resulting BCR and NPV values.

Table 5.7 shows the results for several combinations of input parameters. In general, a low installation rate and a high reduction range will result in the highest BCR. The results are further enhanced if the BCR includes full mobility benefits. The use of the full amount of mobility benefits is debatable as not all drivers whose licence was withdrawn will completely cease to use their cars. However, restricting the mobility benefits to half of the calculated level still yields positive BCR values.

Table 5.7. Sensitivity analysis BCR Scenario 1

Scenario 1 +	Installation rate	Reduction range	Mobility benefits	Participants AIP	BCR
Low reduction range	60%	1.25%	Full	2,521	5.6
High reduction range	60%	3.75%	Full	2,521	8.5
Reduced mob. benefits, worst case	70%	1.25%	Reduced	2,952	3.4
Reduced mob. benefits, best case	50%	3.75%	Reduced	2,090	7.1
Full mob. benefits, worst case	70%	1.25%	Full	2,952	5.5
Full mob. benefits, best case	50%	3.75%	Full	2,090	9.1
Base case reduced mobility benefits	60%	2.50%	Reduced	2,521	5.0

Table 5.8 shows the NPV values for the same combinations of input parameters as in the previous table. Best results were obtained with a combination of full mobility benefits, low installation rate and high reduction range. The latter parameter can probably not easily be altered. Worst case, with high installation rate and low reduction range and limited mobility benefits, results in a BCR of 3.4, while a low installation rate in combination with a high reduction range and full mobility benefits yields a BCR of 9.1

Table 5.8. Sensitivity analysis NPV for scenario 1

Scenario 1 +	Participants AIP	Net Present Value
Low reduction range	2,521	47,987,071
High reduction range	2,521	78,277,462
Reduced mob. benefits, worst case	2,952	28,598,988
Reduced mob. benefits, best case	2,090	54,411,360
Full mob. benefits, worst case	2,952	53,939,233
Full mob. benefits, best case	2,090	72,325,300
Base case reduced mobility benefits	2,521	41,505,174

Table 5.8 shows that a higher reduction range results in higher net present value. Reduced mobility benefits significantly reduce the NPV.

The same exercise was done for scenario 2, in which the AIP is completely funded by the state (*Table 5.9*). The state funding has a positive effect on both installation rate and reduction range but will increase overall costs significantly. The number of AIP participants in scenario 2 is higher for all corresponding input combinations in scenario 1 but the BCR is slightly lower.

Table 5.9. Sensitivity analysis BCR scenario 2

Scenario 2 +	Installation rate	Reduction range	Mobility benefits	Participants AIP	BCR
Low reduction range	77.50%	1.63%	Full	3,276	4.8
High reduction range	77.50%	4.88%	Full	3,276	7.3
Reduced mob. benefits, worst case	90.00%	1.63%	Reduced	3,814	2.9
Reduced mob. benefits, best case	65.00%	4.88%	Reduced	2,737	6.1
Full mob. benefits, worst case	90.00%	1.63%	Full	3,814	4.7
Full mob. benefits, best case	65.00%	4.88%	Full	2,737	7.9
Base case scenario 2 reduced mob. ben.	77.50%	3.45%	Reduced	3,276	4.4

Table 5.10 shows the calculated net present value for the same combinations of input variables as in the previous table. The NPV for each input parameter combination is higher than those of corresponding cases in scenario 1 (*Table 5.8*). The higher number of participants in scenario 2 results in both higher costs and higher benefits. As a result, the BCR is lower but the resulting positive NPV is significantly higher.

Table 5.10. Sensitivity analysis NPV scenario 2

Scenario 2 +	Participants AIP	Net Present Value
Low reduction range	3,276	60,194,615
High reduction range	3,276	99,511,543
Reduced mob. benefits, worst case	3,814	34,404,064
Reduced mob. benefits, best case	2,737	69,051,877
Full mob. benefits, worst case	3,814	67,170,613
Full mob. benefits, best case	2,737	92,535,545
Base case scenario 2 reduced mob. benefits	3,276	54,120,912

The above combinations of scenarios and fixed input parameters are useful to assess the range of possible BCR and NPV values. The R program mentioned in paragraph 4.3 was used to vary the input parameters randomly (Monto Carlo scheme, n=10,000) within a scenario. The results for both input parameter scenarios and for the three casualty development scenarios are shown in *Table 5.11* and *Table 5.12* below.

Table 5.11. Sensitivity analysis for BCR using combined parameters for both scenarios (1. Paid by client, 2. Paid by state) and for each casualty development scenario (a. Constant, b. Estimate, c. EU target dev.). Mobility benefits were varied between half and full benefits.

Scenario	Casualty development scenario	Installation rate	Reduction range	Participants	BCR mean	Standard deviation	Lower 95% interval	Upper 95% interval
1	a	60.05%	2.50%	2,523	6.8	1.5	3.9	9.8
1	b	59.93%	2.50%	2,518	6.1	1.3	3.4	8.7
1	c	60.09%	2.49%	2,525	5.5	1.3	3.0	8.0
2	a	77.49%	3.26%	3,275	5.9	1.3	3.3	8.4
2	b	77.48%	3.25%	3,275	5.2	1.2	2.9	7.5
2	c	77.40%	3.25%	3,271	4.7	1.1	2.6	6.8

The most likely implementation of the AIP, scenario 1 and casualty development scenario b, with an installation rate around 60% and an expected reduction range of 2.5% in combination with mixed mobility benefits will result in a BCR between 3.4 and 8.7, probably 6.1. This is better than the BCR between 2.9 and 7.5 for scenario 2. Best AIP results are obtained if casualty levels stay constant during the appraisal period. The results of the AIP are worst if the EU targets for casualties are met but that would obviously improve road safety. The AIP might help to reach these goals faster. The number of AIP participants is higher for scenario 2.

The results in *Table 5.12* show that the net present value for the most likely scenario combination will be between €24 million and €80 million, probably €52 million. These values are higher than those for the EU target pathway and lower than for scenarios with a constant number of casualties during the appraisal period.

All casualty development scenarios in combination with scenario 2 (AIP fully paid by the state) result in a higher NPV. The most likely result lies between €30 million and €102 million, probably €66 million.

Table 5.12. Sensitivity analysis for the net present value (NPV) in euros, using combined parameters for both scenarios (1. Paid by client, 2. Paid by state) and for each casualty development scenario (a. Constant, b. Prognoses, c. EU target dev.). Mobility benefits were variable between half and full benefits.

Scenario	Casualty development scenario	NPV mean	Standard deviation	Low 95% interval	High 95% interval
1	a	60,664,512	15,799,052	29,698,370	91,630,654
1	b	52,450,096	14,123,158	24,768,705	80,131,486
1	c	46,905,410	13,292,574	20,851,965	72,958,856
2	a	76,687,099	20,372,700	36,756,607	116,617,592
2	b	65,938,392	18,416,727	29,841,606	102,035,178
2	c	58,378,565	17,119,131	24,825,068	91,932,061

The basic casualty development scenarios (b) were calculated for the mean values of the casualty estimates and therefore only depend on variations in installation rate, reduction range and mobility benefits. The development of the number of casualties itself during the appraisal period is another source of uncertainty. The 68% confidence interval provides boundaries to test the influence of this uncertainty. Calculations were made with the lower and higher confidence boundaries as input. Installation rate, reduction range and mobility benefits were allowed to vary with random input parameters (Monto Carlo scheme, n=10,000) within a scenario. The results of these calculations are shown in *Table 5.13*. For scenario 1, the expected BCR ranges between 2.9 and 10.2 and an NPV between €19 million and €95 million. For scenario 2, the BCR will be between 2.5 and 8.8 with an NPV between €22 million and €122 million.

Table 5.13. Sensitivity analysis for BCR and NPV in euros using combined parameters for both scenarios (1. Paid by client, 2. Paid by state) and casualty development scenario b. The type indicates the input series used for casualty development (mean and its 68% confidence interval values). Mobility benefits were variable between half and full benefits.

Scenario	Type	BCR mean	Standard deviation	Lower 95% interval	Upper 95% interval	NPV mean	Standard deviation	Low 95% interval	High 95% interval
1	low 68%	5.3	1.2	2.9	7.6	44,221,985	12,718,372	19,293,976	69,149,995
1	mean	6.1	1.3	3.4	8.7	52,450,096	14,123,158	24,768,705	80,131,486
1	high 68%	7.1	1.6	4.0	10.2	63,394,655	16,288,779	31,468,649	95,320,661
2	low 68%	4.5	1	2.5	6.5	55,239,527	16,583,001	22,736,845	87,742,208
2	mean	5.2	1.2	2.9	7.5	65,938,392	18,416,727	29,841,606	102,035,178
2	high 68%	6.1	1.4	3.5	8.8	80,465,996	21,115,089	39,080,420	121,851,571

All random estimations result in positive BCR (i.e.>1) and NPV (i.e.>0) values. The mean estimations for installation rate and reduction range for scenario 1 are very close to the input values that were used for the base case. The mean BCR and NPV are slightly lower than those of the base case. This is mainly because the mobility benefits were not fixed to the higher full mobility benefits. The standard deviations on BCR and NPV are rather large but result in entirely positive 95% confidence intervals.

In general, a low installation rate, a high reduction range, and application of full mobility benefits favour high BC ratios. If program costs are fully borne by the state, the number of participants and the NPV will rise considerably. In these cases, the BC ratio drops a little because, relatively, the total costs increase more than the total benefits.

6 Conclusions

This study has some limitations (*Section 6.1*) that need to be understood in order to interpret the conclusions in this chapter correctly. The research questions are answered in *Section 6.2* and the goal of this study, a CBA for an Irish AIP, is achieved in *Section 6.3*.

6.1 Limitations

Several assumptions needed to be made for this CBA. In all cases, relevant literature or plausible reasoning was available. This means reasonable margins could be used in the sensitivity analyses. Of course, better estimates would have resulted in smaller margins and more precise BCR and NPV estimates.

A comparison of Ireland to other countries (benchmark) was based on WHO 'objective' numbers and ESRA-2 subjective opinions of road users. WHO makes adjustments for official statistics given by countries themselves because it is known these vary (a lot) in quality. It is likely these adjustments overcompensate, nevertheless we preferred to use these numbers because it is not the percentages as such that are used in a benchmark but the relative shares in different countries

6.2 Research questions

To meet the goal of this research, answers to sets of research questions (RQ) are given. These questions are:

1. What is the number of casualties *to be* reduced by the AIP?
2. What are the probable characteristics of the (Irish) AIP?
3. How effective is an AIP and which elements determine this effectiveness?
4. Which methodology and data are used to determine the BCR and NPV?
5. What are the BCR and NPV for different scenarios?
6. How sensitive is the outcome (i.e. BCR and NPV) to the most relevant parameters?

6.2.1 Casualty numbers *to be* reduced

It is assumed that an alcohol interlock can only be installed in cars and vans. Therefore the number of fatalities, serious and minor injuries in a crash involving these vehicles is the number an AIP is meant to reduce. Based on statistics in 2018, these casualty numbers are:

- 30 fatalities (26% of 114 fatalities)
- 229 serious injuries (21% of 1089 serious injuries)
- 363 minor injuries (6% of 6045)

Numbers differ from year to year, percentages are assumed to be constant. If in a year there are more fatalities, the benefits of an AIP are higher because more lives will be saved. The CBA concerns the period 2021-2030 (10 years) for which three different scenarios have been considered. The most likely road safety trend is based on a state-of-the-art local linear trend model. A more positive trend according to EU policy, assumes numbers will be halved in a decade. A more negative trend assumes road fatalities stay at the 2018 level.

6.2.2 Characteristics of an Irish AIP

For the purposes of Action 121, the AIP is assumed to be a two-year mandatory program. This will allow a more accurate estimate of the target group, the percentage of repeat drink-drivers who will participate in the AIP.

It is assumed that the participant bears the cost of the alcohol interlock program, as is general practice internationally (e.g. Netherlands, Sweden, Finland and France and other countries). However, the CBA was also made for an alternative AIP scenario where costs are fully borne by the state of Ireland. This was done because it will have a positive effect on participation rate and subsequently the benefits of the program.

For this report the costs outlined in the Dutch AIP (Gouweleeuw, 2014) will be used as they are the most recent & detailed cost figures available for an AIP.

6.2.3 Effectiveness

The effectiveness of an AIP was best researched in the United States. They found an effect of 2% with a 95% confidence interval (C.I.) between 1-3%. The US AIP is comparable to the Irish proposal but the Irish road safety and drink-driving situation could be different. In general, we expect that an AIP performs better when enforcement levels are higher, installation rates are higher, the drink-driving problem is serious and the country has a more evolved road safety culture. Compared to the USA, enforcement levels are higher in Ireland, participation rate is the same, the drink-driving problem is slightly more serious and road safety levels substantially better, i.e. Ireland has a better road safety culture. Therefore, we estimate effectiveness to be 25% higher. The 95% C.I. is between 1.25-3.75%.
This is estimated to be 30% higher when the state bears the costs instead of the participant, resulting in a 95% C.I. between 1.6-5.0%.

6.2.4 Methodology and data used

In a CBA, the costs and benefits of a policy intervention are determined relative to a baseline scenario, i.e. what would have occurred in the absence of the proposed AIP. Current policy is driving licence withdrawal for repeat drink-drivers. For this CBA, the disqualification period is assumed to be 2 years on average. Costs that remain unchanged are for instance drink-driving enforcement and public campaigns. Costs that are eliminated are administrative costs related to withdrawing/returning the driving licence and the related registration. Costs of the AIP include e.g. implementation of legislation and organisation, the alcolock devices and installation, and data handling.

It is assumed that the AIP will be introduced in 2021 and will run until the end of 2030. All costs and benefits are discounted to present values. The 4% discount rate that has been set by the Department of Public Expenditure & Reform in the Public Spending Code (DPER, 2019) is applied. The base year is 2018 and all costs and benefits are expressed in price level 2018. The implementation costs are determined at €1.8 million, administrative costs per participant at €3,829 thousand (€4,978 thousand when the state bears these costs) and time costs at €732 per participant.

To calculate the monetary safety benefits, the annual number of avoided fatal, serious and minor injuries in the appraisal period are multiplied by the monetary valuations per casualty. Crash-related costs are converted to costs per avoided casualty using the number of casualties per crash. According to international standards, the socio-economic costs of road crashes include medical costs, production loss, human costs, property damage, administrative costs and other

costs, e.g. congestion. For the calculation of the mobility benefits, we follow the 'generalised costs approach' consisting of the total costs of travelling which include vehicle operating costs (private transport), ticket costs (public transport) and time costs.
The resulting monetary values per prevented casualty are (2018 prices):

- Fatality: €3,349,082
- Serious injury: €384,321
- Slight injury (including Property Damage Only PDO): € 48,716

As in any CBA. there are assumptions and uncertainties regarding most parameters used in the applied method and (computer) model. To assess their effect on the outcome (BCR and NPV) we varied all major input parameters and looked at their interaction. The resulting model with variable and fixed input variables was put in a program loop to generate 10,000 results for a particular input configuration. The use of this loop in combination with the randomised input parameters renders it possible to calculate statistical parameters like mean, standard deviation and extremes for an input configuration. Fixing some of the parameters while varying others, made it possible to focus on particular interactions between input parameters.

6.2.5 Results for different scenarios

We applied the methodology to the number of casualties, the Irish AIP and the assumed effectiveness for different scenarios depending on who bears the costs (scenario 1 participant/ scenario 2 state), road safety trends (scenario a: level 2018/b: local linear/c: EU-policy) and effectiveness (low/high). The outcome is a benefit to cost ratio (BCR, benefits divided by costs) and a net present value (NPV, benefits minus costs). For maximum efficiency BCR should be chosen, for maximum effectiveness NPV should be chosen.

Table 6.1. Summary of the results of the total incremental benefits and costs for the base scenarios and the resulting benefit cost ratio and net present value

Overall Summary of benefits and costs (€) over the appraisal period of 2021-2030				
Scenario	**Scenario 1, low reduction range**	**Scenario 1, high reduction range**	**Scenario 2, low reduction range**	**Scenario 2, high reduction range**
Present value of total benefits	58,399,655	88,690,060	75,939,328	115,316,855
Present value of total costs	10,412,462	10,412,462	15,804,622	15,804,622
Net present value (NPV)	47,987,193	78,277,598	60,134,706	99,512,232
BCR	**5.6**	**8.5**	**4.8**	**7.3**

Table 6.2. Benefit cost ratio and net present value (€) for alternate casualty development scenario a

Alternate development scenario a: the number of casualties remains at the 2018 level over the appraisal period of 2021-2030				
Scenario	**Scenario 1, low reduction range**	**Scenario 1, high reduction range**	**Scenario 2, low reduction range**	**Scenario 2, high reduction range**
Net present value (NPV)	52,167,296	90,818,136	65,568,326	115,814,418
BCR	6.0	9.7	5.1	8.3

Table 6.3. Benefit cost ratio and net present value (€) for alternate casualty development scenario c

Alternate development scenario c: the number of casualties follows the pathway to reach the EU targets in 2030 over the appraisal period of 2021-2030				
Scenario	**Scenario 1, low reduction range**	**Scenario 1, high reduction range**	**Scenario 2, low reduction range**	**Scenario 2, high reduction range**
Net present value (NPV)	45,232,114	70,012,590	56,552,590	88,767,209
BCR	5.3	7.7	4.6	6.6

The most likely implementation of the AIP, scenario 1 and casualty development scenario b, with an installation rate around 60% and an expected reduction range of 2.5% in combination with mixed mobility benefits will result in a probable BCR of 6.1 and an NPV of 52 million euros.

6.2.6 Sensitivity analysis

The output of a model is sensitive to variations in the input parameters used. The input parameters are based on assumptions from the literature and uncertainties in effectiveness. To gain insight into the sensitivity of the output to randomised variations in input parameters, a sensitivity analysis was performed.

All random estimations result in positive BCR (i.e.>1) and NPV (i.e.>0) values. Extremes for the BCR are 2.5 and 9.8. For the NPV, these are €19 million and €122 million. In general, a low installation rate, a high reduction range, and application of full mobility benefits favour high BCRs. If program costs are fully borne by the state, the number of participants and the NPV will rise considerably. In this case, the BCR drops somewhat because the total costs increase relatively more than the total benefits.

6.3 Goal: benefit cost ratio (BCR) and net present value (NPV) of an alcohol interlock program (AIP) for Ireland

The main goal of this study is to determine the two elements of the desired cost benefit analysis: the benefit to cost ratio (BCR) and net present value (NPV) of an Irish Alcohol Interlock Program (AIP). The most likely Irish AIP, with average effectiveness and a probable road safety forecast, results in a BCR of 6.1 and an NPV of 52 million euros. This implies an Irish AIP is likely to be efficient and effective.

Both BCR and NPV are sensitive to participation rates, effectiveness of the AIP and mobility effects. Using combined parameters and taking account of standard deviation, the BCR varies between 2.5 and 9.8. The NPV varies between €19 million and €122 million. Note that in all cases both BCR and NPV are (very) favourable and the maximum BCR and maximum NPV occur at different settings.

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Appendix A:
Overview USA effectiveness studies

“Kaufman and colleagues employed a difference-in-difference approach, using year-level data, to assess the effects of laws relating to mandatory interlocks/all-offender interlocks on fatalities resulting from crashes in which a driver had a BAC40. The study by McGinty et al. (2016) assessed laws relating to mandatory/all-offender interlocks and relating to interlocks for specific offender segments, and took the precise month of legality into account. The primary outcomes were BAC Z0.08 and BAC Z0.15 fatal crashes, measured at the crash level rather than individual fatality level, which could skew results because of outlying multiple-fatality incidents.”

Kaufman and Wiebe mention some limitations in their approach. The study did not/could not account for local laws that might have been stricter than state requirements, for additional features of interlock laws that varied among states (several states made changes to interlock requirements, penalties, monitoring, and administration during the study period), for different enforcement levels between states, and for differences in AIP installation rates.

McGinty et al. (2016) mention the following limitations. The FARS data use multiple imputation to address missing data for alcohol-involved crashes, which could introduce measurement error. The multilevel modelling approach may have missed some important time-varying confounders, and the study did not consider specific interlock law provisions, such as supervision and monitoring requirements and differences in implementation and enforcement of interlock laws across states.

Teoh et al. (2018) found that all-offender interlock laws were effective at reducing fatal crashes of impaired drivers (16% fewer drivers with BAC 0.08+), compared with no laws. Repeat-offender laws were associated with a small benefit (3% reduction in impaired drivers) compared with no law, and there was an additional benefit of including high-BAC offenders (8% compared with no law). The researchers also found larger benefits for drivers with prior DWI convictions, which could be interpreted to mean that an additional specific deterrence effect appeared.

Teoh et al. (2018) mention some limitations. Their study did not assess the possible effect on non-fatal alcohol-related crashes and they did not include alcohol consumption. Nor did their study investigate actual interlock installation rates. They also refrained from addressing the possible difference in effect of interlock laws that require installation to drive during post-conviction licence suspension versus laws that require installation to reinstate a driver licence after conviction. (Own observation: the authors do not discuss the issue of how comparable their comparison group is.)

The four studies in *Table A.1* below all have their strengths and weaknesses. Arguably, the best estimates are from the McGinty et al. 2016 study. This study has several advantages over the three other studies:

- the longest time frame (1982-2013)
- data on monthly level
- data on crash level (instead of individual fatalities such as in the Kaufman & Wiebe study)
- separate estimates for crashes ≥ 0.08 BAC and ≥ 1,5 BAC
- supporting sensitivity analyses.

Table A.1. Characteristics and results of four recent USA studies of AIP effectiveness.

	Ullman 2016	Kaufman & Wiebe 2016	McGinty et al. 2016	Teoh et al. 2018
Country	USA; 49 states	USA; 50 states	USA; 43 states	USA; 45 states
Period	2001-2012	1999-2013	1982-2013	2001-2014
Type of AIP investigated	AIP for first-time offenders: 1. applied to drivers convicted of having BAC.08 or higher ("strong treatment"); 2. applied to drivers convicted of having BAC.15 or higher ("weak treatment")	Mandatory (universal) AIP: all DUI offenders	Partial AIP: interlock use for specific group of offenders, e.g. repeat offenders and/or high BAC offenders. Mandatory AIP: all DUI offenders.	Types interlock laws: no law, AIP for repeat offenders, AIP for repeat offenders and high-BAC offenders, or AIP for all offenders.
AIP conditions investigated	AIP only for drivers with BAC.15 or higher ('weak treatment') vs. AIP applied to drivers convicted of having BAC.08 or higher ('strong treatment'). The data consist of 49 states (12 'weak-treatment' states, 17 'strong-treatment' states, 20 remaining states are controls).	18 states with mandatory (universal) interlock	Partial vs. mandatory In total, 36 states enacted partial interlock laws; 21 states, 13 of which already had partial interlock laws in effect, enacted laws for mandatory/all-offender interlocks during the study period	AIP for all offenders, AIP for repeat offenders and AIP for high BAC and repeat offenders
Method	Difference-in-difference estimation methods	50-state difference-in-difference analysis; each state its own pre-post control	Multilevel modelling	Poisson regression with a log link and an estimated scale parameter to allow for overdispersion.
Data characteristics	Fatality Analysis Reporting System (FARS) of the NHTSA; counts of monthly fatal accidents per state, linked to state-level legislative data on strong and weak mandatory installation of the IID for first-time offenders. The data are evaluated over a 144-month period for a total of 7056 observations.	Annual data 18 implementing and 32 non-implementing states	384 month-level observations for 43 states; alcohol-related fatalities from FARS database	Primary analysis unit was the state-quarter. Data on passenger vehicle drivers involved in fatal crashes during 2001–2014 were extracted from FARS database.
Comparison group	States without AIP for first-time offenders in 2001-2012	States without policy as additional control	Only 7 states did not implement a law relating to mandatory/all-offender interlocks or relating to interlocks for specific offender segments during the study period; these states tended to be rural states with relatively small populations (…).In view of this, identification of an uncontaminated control group with similar demographics and trends in alcohol-involved fatal crashes was not feasible.	By 2014, 20 states required interlocks for all DWI offenders, 13 for repeat and high-BAC offenders, and 12 for repeat offenders only – leaving 5 states and the District of Columbia (…) that did not require interlocks for any specific group of offenders.

	Ullman 2016	Kaufman & Wiebe 2016	McGinty et al. 2016	Teoh et al. 2018
Models	Standard difference-in-difference fixed effects model:	Results simple OLS regression most conservative and therefore chosen over OLS regression on log-transformed outcomes, negative binomial regression, and generalised linear modelling	Negative binomial regression using random effects generalised linear models, with a random intercept for each state, was used to assess the effects of interlock laws on alcohol-involved fatal crash rates. Random-intercept models allow for variation in underlying alcohol-involved fatal crash rates across states while also accounting for autocorrelation of within-state crash rates over time. All models included licenced drivers as a population offset term, making results interpretable as incidence rate ratios.	Six models: prior DWI status (2: yes/no) x BAC levels (all, > 0.08+ g/dL; > 0.15 g/dL) = 6 models
Analysis	Standard difference-in-difference fixed effects model:	Ordinary least square regression with standards errors adjusted for clustering at state level across years	Negative binomial regression using random effects generalised linear models	Poisson regression with a log link and an estimated scale parameter to allow for overdispersion
Covariates/ Variables controlled for	The log of the population for each state, the proportion of males, the proportion of specific races, the median age in each state, and real income per capita represented in 2012 dollars, the prevailing gasoline tax, beer tax, and unemployment rate, policy variables for .08 BAC limits (BAC.08), open container (OPEN) laws, policies directed at reducing underage drinking, which are licence suspension or revocation for underage purchase, possession, and consumption (UND21) and liability for hosting underage drinking parties (PARTY).	State highway speed limits, vehicle miles travelled, traffic safety law changes (primary seat belt enforcement, motorcycle helmet requirement, booster seat requirement, bicycle helmet requirement for children)	BAC 0.08 laws, zero tolerance laws, primary seat belt enforcement laws, national rate of alcohol-involved fatal crashes, linear time trend (downward)	Covariates included interlock laws, per se laws, state, quarter, unemployment, and counts of passenger vehicle drivers involved in fatal crashes that did not involve any impaired drivers. Interaction terms were included between drivers in unimpaired fatal crashes and state, quarter, and unemployment rate to allow for these relationships
Dependent/ outcome variables	Monthly nr. of fatal accidents in a state for which a driver's imputed BAC is higher or equal to .08 and the monthly nr. of fatal accidents in a state for which a driver's imputed BAC is higher or equal to .01	Alcohol-involved crash deaths defined as those in which at least 1 driver had a BAC level higher than zero.	Alcohol-involved motor vehicle crashes in which one or more people were killed in in proportion to total number of licenced drivers in a given state	Impaired drivers in fatal crashes

	Ullman 2016	Kaufman & Wiebe 2016	McGinty et al. 2016	Teoh et al. 2018
Robustness/ Sensitivity analyses	1. Robustness of the dependent variable was estimated by an alternative dependent variable and two other definitions of the number of alcohol-related fatal accidents; 2. to test the sensitivity of the linear results using log crashes (instead of levels), the number of alcohol-related fatal crashes were measured for the dependent variable; 3. refine the control group using propensity score analysis	To assess impact of unmeasured binary confounder (e.g. other policy/policies)	3 sensitivity analyses on model 2 defining 3 different time delays (12, 24 and 36 months lagged interlock indicators)	None
Robustness results/ Results sensitivity analyses	Estimates were consistent across county- and state-level models, robust to an alternative measure of individual BAC, and to several alternative definitions of the dependent variable	The sensitivity analysis to demonstrate the impact confounders demonstrated minimal impact on the effect size and significance of main result.	Lagged models suggest possible scale-up effects for interlock laws related to specific offender groups , with these laws showing significant protective effects on both BAC ≥0.08 and BAC ≥ 0.15 fatal crash rates when 24-month or 36-month lags were added.	None
Estimated reduction	"Strong" II laws for first-time offenders reduce the number of fatal crashes involving a drunk driver by 9%; non-significant result for "weak" II laws	Estimated effect mandatory AIP for all; 15% reduction in the rate of alcohol-involved crash deaths	Mandatory/all-offender interlock laws on alcohol-involved fatal crashes were associated with an estimated 7% reduction in BAC ≥0.08 and 8% reduction in BAC ≥ 0.15 fatal crashes. No effect of interlock laws related to specific offender groups on alcohol-involved fatal crashes in best model (Model 2).	3% reduction AIP for repeat-only vs. no law 8% reduction AIP for high BAC and repeat offenders vs. no law 16% reduction AIP for all

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