

## **Influence of stability control for fatal car accidents in Finland**

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KEYWORDS – ESC, Active safety, Fatal car accident, Traffic safety, Loss of control

### ABSTRACT

Active safety systems have become common equipment in all size categories of cars. However, the advantage of active safety systems are easily hidden behind the passive safety systems, which only mitigate the consequences of the crash. Active safety systems primarily prevent accidents and secondary mitigate the consequences.

Vehicle manufactures and vehicle systems suppliers have many differently named stability control systems, which are all based on the same principle. The best known is ESP (Electronic Stability Programme) by Bosch, but ESC (Electronic Stability Control) has been agreed on as the common name for all stability controls.

Vehicle behavior is found to be non-linear during extreme driving maneuvers, which typically occur when the driver has lost the control of his car. The driver adapts himself for a certain response of the car during normal driving. In extreme maneuver, the driver still controls the car based on this earlier routine, but the vehicle does not respond as predicted. The ESC regulates this difference between nominal and actual behavior of the car.

In theory, ESC could prevent all the crashes due to the loss of control. By contrast, it cannot prevent any crashes caused by drift off the lane or if the turn is entered extremely fast.

The research covers fatal car accidents in Finland in 2000-2006 for cars, whose commissioning date fall between these years. The benefit of ESC is clearly visible in the data. The results are similar to the studies made in Sweden and Germany. However, in Finland the number of relevant accidents is smaller than in other western countries, because of the old age of the vehicle fleet.

The ESC would have saved 31 human lives during the seven years (2000-2006), which is only 4-5 per year. However, due to the old age of Finnish fleet, the control group included only 171 fatal car accidents. Thus, the relative effectiveness of ECS was found to be 18 %.

An interesting comparison could be made between an ESC and a median barrier, which both can reduce head-on collisions effectively. The median barrier is an expensive investment for the road keeper, but ESC is paid directly by the road end-users, who in addition pay the car-tax and VAT for ESC.

## INTRODUCTION

ESC (Electronic Stability Control) is the common name for such products as ESP (Electronic Stability Program), VDC (Vehicle Dynamics Control), DSC (Dynamic Stability Control), DSTC (Dynamic Stability and Traction Control) and ASC (Active Stability System). Traction controls like TSC (Traction control) and ASR (Acceleration Slip Control) are more simple devices than the previous. Traction control feature belongs always to an ESC. All ESC devices work on the same principle, so that ESC fixes the difference between driver based nominal handling and the actual behaviour of the car. However, ESC doesn't compensate driver's mistakes, but makes the car to behave according to driver's will. In Principle, the system helps the driver to keep the car under control in most situations.

ESC helps in keeping the car within the neutral handling area. Within this area, friction enables the side force production of all four tyres. Especially, on snow and ice it's important to utilize all available friction. Under bad weather conditions typical fatal accident take place when the driver loses the control of his vehicle on a highway turn and consequently crashes into an oncoming vehicle. Poor tyres or low friction don't eliminate the function of the ESC.

ESC reduces speed when it gets activated. This is because the ESC functions by braking each wheel independently. This is a very important point in the case the situation leads to a crash. In Finland, a typical fatal, single car accident takes place under good weather conditions when a young man enters a tight turn too fast on a small highway, hence losing the control of his vehicle. ESC would reduce consequences in these accidents.

In theory, ESC could prevent all accidents where the car starts to swerve. On the other hand, ESC can't prevent the accident, if the speed is too high. However, it reduces the speed at crashing and makes the car slide head-first. The difference is huge, if the car crashes into a fixed object sideways at a speed of 80 km/h or front end first at speed of 60 km/h.

## LITERATURE RESEARCH

In our study, we wanted to find out the influence of stability control systems in fatal accidents in Finland. However, similar studies have also been carried out in other countries and below we compare our results with the ones from previous studies.

### Sweden

We have a great interest in research made in Sweden, as the weather conditions are similar in Sweden and Finland. Swedish National Road Administration has made two different studies. The data for these studies was provided by the Swedish police. The first study was written on accidents that took place between years 2000 and 2002, and was published in 2004 (table 1). According to this study the biggest benefit from ESC is gained in winter and wet conditions. The ESC efficiency was also higher in large front wheel drive cars than in large rear wheel drive cars. [1]

Table 1: Results from the 2000-2002 study

Accident type	ESC efficiency 95% confidence level
All accidents	22,1 ± 21,0
Accidents on dry	9,3 ± 28,3
Accidents on wet	31,8 ± 23,4
Accidents on snow/ice	38,2 ± 26,1

The second study is based on the accident data from the time period 1998-2004. This study includes over 10000 accidents, within which 1942 cars were equipped with the ESC. The results from this study were similar to the ones gained from the first one. However the result reliability was higher this time (table 2). Here, the benefit gained from the ESC was detected as greatest in single car accidents (table 3). [2]

Table 2: Results from the 1998-2004 study

Accidents	ESC efficiency 95% confidence level
All accidents	16,7 ± 9,3
All accidents passengers	23,0 ± 9,2
Civil injury/fatal accidents	21,6 ± 12,8
Civil injury/fatal accidents passengers	26,9 ± 13,9

Table 3: Results by accident type in the 1998-2004 study

Accident type	ESC efficiency 95% confidence level
Single car, overtake or opposite directions, civil injury	31,0 ± 10,2
Single car, overtake or opposite directions, serious civil injury/ fatal	40,6 ± 15,1
Single car, serious civil injury/ fatal	44,4 ± 19,6

#### Other countries

In UK it has been found that cars with the ESC end up in accidents 3% less often than cars without the ESC. ESC was also detected to reduce the accidents causing serious civil injuries or fatalities by 19%. The efficiency of the ESC increased in wet or icy conditions. [3]

In Germany, GDV (insurance company association) estimates that the ESC reduces civil injuries by 25% in all accidents and 40-60% in single car accidents. [4]

#### METHOD

In Finland, 1464 fatal car accidents, caused by a passenger car, occurred between years 2000 and 2006. Most of the fatalities took place in twenty-year old cars, as the Finnish car fleet is old and older cars are in principle less safe than newer ones. In this research we are interested only in 21-century cars. Within these boundary limits we had 146 accidents where 171 persons died and 148 were injured. In Finland, we don't have enough data from new cars in fatal accidents, hence we couldn't use statistical methods.

Due to low number of accidents, all accidents were analysed separately. Accidents were divided into three groups where ESC could have helped. These groups were:

- Cars with same directions, no rear-end collisions into turning or braking car
- Cars with opposite directions
- Driving off the road

Accidents with animals and pedestrians were excluded from this study, because the behaviour of these participants is in a too big of a role in these accidents. Accidents taking place in crossroads were included in this study, although the influence of the ESC is low in these kinds of accidents.

Accident types were analysed in two categories. The first category contains the accidents where the ESC didn't help. The second one contains the accidents where the ESC could have helped. The accident types within the second group were: Losing control in difficult weather conditions, Losing control in crossroads and losing control in tight turns.

## RESULTS

In Figure 1 we can see prevalence of ABS and ESC in research data. You could expect that all new cars have been equipped with ABS for long time now, however, 20% of the cars didn't have the system. 9% of the cars had ESC. In 48 cases we couldn't find out whether the car had an ESC or not, as reliable data was not available or ESC hadn't influenced these accidents.

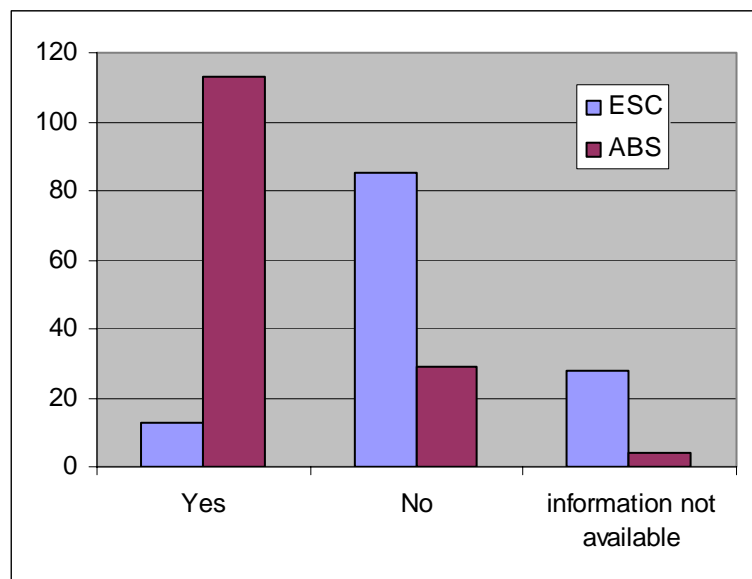


Figure 1: Cars equipped with ESC or ABS (in research data)

Figure 2 shows that ESC could have benefitted in 58% of the accidents. Practically there is no significant difference whether we compare the number of accidents or the number of fatalities. ESC would have prevented some 18% of all accidents. In fatal accidents, 32% of the injured would have been saved.

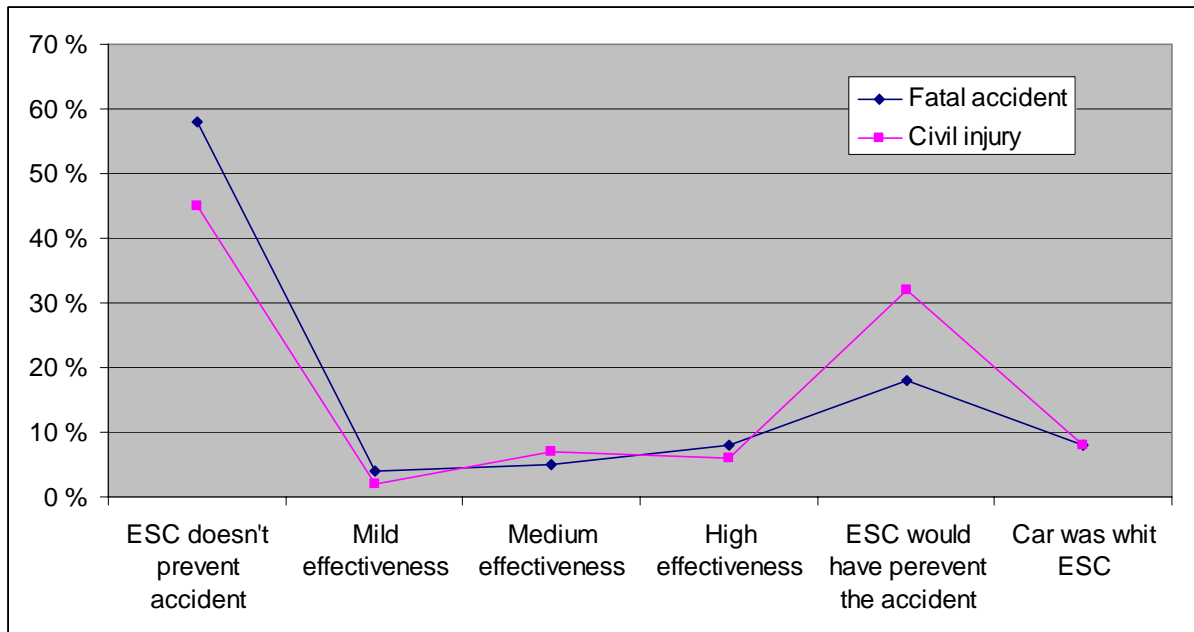


Figure 2: Fatal accidents and civil injuries in effectiveness clashes comparing to total number of accidents (in research data).

The number of accidents studied here is low when compared to the total number of accidents. For example, ESC would have saved 31 lives within seven years. This might sound like a low effectiveness, however, this kind of evaluation is incorrect as only accidents faced by new cars were considered in this research. Thus, a more appropriate way is to compare these 31 possible lives saved to the 171 lives lost. This means that ESC would reduce the number of fatalities in car accidents by 18%.

We didn't use effectiveness classes of ESC because in most cases the effectiveness was clear, but lost lives were sorted according to the accident type. In most cases fatal accidents for new cars are driving off the road and head-on collisions. There were 20 accidents in crossroads and the ESC could not have helped in these cases. We also compared the effectiveness of the ESC between different regions and didn't find any remarkable differences.

Our data included many accidents caused by entering a turn far too fast. In these cases only reducing the speed helps. In many cases marks that indicated the swerving of the car before the crash were found. Some cases also ended to the concave side of the turn. This means that all friction available was not utilized in keeping the car on the road. There were only very few accidents where the car had gone off the road straight to tangential direction.

## DISCUSSION

Benefit of the ESC for the traffic safety was clear in our study. The results were quite similar as the results from Sweden or Germany for example.

There may be some risks which reduce the benefits of the ESC:

1. Driving on the limit with the help of the ESC
2. Switch off possibility
3. Cheap insufficient versions

The biggest risk is that people start driving faster and less carefully when possessing the ESC. This might happen in some cases. However, similar beliefs were in the air when ABS became more common, but nowadays hardly anyone takes risks in traffic solely based on the ABS capability in panic braking. In effect, ABS eliminated one accident type, losing control in panic braking and hence the benefits were certainly greater than the disadvantages.

Most of the drivers will never understand how ESC works and when it works. They might know that the system will help when sliding. The system comes with the car like the seatbelts or the airbags. We believe that most of the people hope that they never need to be familiar with the system in real life and they will not reclaim benefits of the ESC.

In many cars you can switch-off the ESC with a single press of a button. Hence, there is the added risk that some drivers will not use the system. They have explanations based on rumours or they just don't want a computer to help them in driving. These people have in most cases a wrong attitude towards traffic and they belong to a risk group.

If ESC will be compulsory in cars, there have to be some kind of a method to control the effectiveness of the system in each car. Some manufacturers might try to save costs and build a system that isn't as good as the systems are now.

An interesting comparison could be made between the ESC and the median barrier, both of which can reduce head-on collisions effectively. The median barrier is an expensive investment for the road keeper, but ESC is paid directly by the road end-users, who in addition, pay the car-tax and VAT for ESC. Median barrier question is very important in the future because head-on collisions are the most common fatal accident type for new cars.

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