STUDYING THE EFFECTS OF SEATBELT WEARING ON THE CONSEQUENCES OF ROAD ACCIDENTS

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Abstract: Undertaking of accurate increasing safety belts using share actions requires possession of these data up to now and conduction of changes resulting actions monitoring. So far, in Poland, nobody was concerned with this problem. That is why in year 2002, in Poland, started implementation of road traffic participants monitoring system project. In the paper are presented its characteristics and survey results.

1. Introduction

The safety of the driver and car occupants largely depends on how well the vehicle and its equipment meet the standards of passive and active safety. The simplest and yet the most effective passive safety device of a car are the seatbelts, which when worn, are often the only chance to save lives when an accident occurs. It is estimated that if all road users used seatbelts, as many as 70% of the fatalities would survive.

One of the priorities of Poland’s GAMBIT 2005 National Road Safety Programme 2005 - 2013 [1] is to improve seatbelt wearing rates. It is important to know how many drivers and car occupants wear seatbelts, when preventative or repressive policies are planned. On the other hand, obtaining this information is difficult, because police officers tend to leave it out from their accident reports. This is why a number of countries, including Poland, have introduced systems for monitoring seatbelt wearing at selected study points on the road network.

Seatbelts were first used in 1930, but it was not until the fifties of the last century that they were installed in vehicles during production. Until 1985 seatbelts were only used in exceptional cases (by not more than 15% of drivers and car occupants). However research and road safety programmes carried out in a number of countries suggested that seatbelts are one of the cheapest and most effective ways to protect road users.
2. System for monitoring seatbelt wearing

Police accident statistics shows that in Poland between 1999 and 2004 99% of injured and 97% of fatalities of road accidents were using restraints (seatbelts, child seats) [2]. However, studies of drivers and vehicles over the same period showed that a mere 66% of road users used restraints in vehicles. Other countries had similar findings. This is why it is important to introduce and develop a system for monitoring seatbelt wearing by road users in vehicles. [3, 4].

In 2002 Poland launched a project designed to build a system for monitoring selected road user behaviours. One component of the project looks at seatbelt wearing rates in the different regions of Poland.

The national system for monitoring seatbelt wearing comprised by September 2005 16 selected study points in all regional capitals. The study began in the second half of 2002 in a project commissioned by the Ministry of Infrastructure. The observation is carried out in the same locations, on average, every two months. Until September 2005 15 study sessions were conducted, funded under a World Bank contract. Since November 2005 the studies have been continued as part of the TRANSPORT Sectoral Operational Programme; there will be 12 more sessions by June 2008 [5], [6]. The study points network has now been extended to include additional 16 study points on national roads in non-built-up areas (one point in each region).

All the studies looked at the number of drivers or car occupants using seatbelts by types of vehicles. In statistical terms, it is the relative frequency of road users wearing seatbelts. To help with the observation, study points were located at signalised junction entries (vehicles stop frequently and drive at lower speeds). The study points were selected with the help of the experience of other countries, which have had this system for a number of years [9,10,11].

Regional systems. The study was conducted in the Pomorskie region [7, 13] in August 2003 (only in selected tourist destinations) and in September 2003 (at all study points), and in the Warminsko–Mazurskie region [8, 14] in August and September 2004.

3. Analysis of the seatbelt study results

The results of the studies covering a period of more than three years were used to conduct a number of analyses. A series of sixteen study sessions covered 552.1 thousand drivers and 278.5 thousand occupants of passenger cars, trucks and taxis. Below is a synthetic overview of selected analyses looking at the type of vehicle, type of road user, age and gender of road users, time of day and week, type of area and region.
Type of vehicle and road user. In the first nine study series seatbelt wearing was observed in three types of vehicles: passenger cars, taxis and trucks. As an example, the error in 16 study series was 1.4 – 6.8 % (depending on the region and type of road user). The percentage of road users wearing seatbelts was calculated as follows:

\[
\text{USP} = 100\times \frac{\text{LUS}}{\text{LU}}
\]

(1)

where:
USP – users wearing seatbelts within the study population [%],
LU – number of road users studied [individuals],
LUS – number of road users studied wearing seatbelts [individuals].

In the first part of the study the cumulative results showed that seatbelts were used by:
- 59.6% of those using passenger cars, taxis and trucks,
- 68.9% of those using passenger cars,
- 13.7% of those using taxis,
- 28.4% of those using trucks.

As regards the types of road users in passenger cars drivers and front seat occupants used seatbelts in 71.1% and 70.7% of cases respectively, with back seat occupants wearing seatbelts less frequently at 49.4% of cases.

Area. The sixteenth study session looked at seatbelt usage by drivers and front seat passengers in passenger cars in non-built-up areas. The results showed that road users using national roads outside built-up areas use seatbelts 5.0% more often than in regional capitals. The regional studies (in two regions: Pomorskie [7] and Warmińsko-Mazurskie [8]) the results suggest that:
- there are significant differences in seatbelt usage from county to county,
- in county capitals road users use seatbelts by 11.5% less often than in regional capitals,
- in small towns on national and regional roads seatbelt usage is 15.7% lower than in regional capitals,
- in rural areas seatbelt usage is by 23.0% lower than in regional capitals.

4. Evaluation of seatbelt wearing

Poland compared to other countries. The results were analysed and it was established that road users using passenger cars in built-up areas [4]:
- in Sweden, Germany, Canada, New Zealand, Japan, United Kingdom and France use seatbelts more than Polish people,
- in Poland use seatbelts at a satisfactory level, but things could be better,
- in the Czech Republic, Hungary, Switzerland and Austria use seatbelts less than Polish people.
Regions. The results of the sixteenth study session looking at seatbelt wearing by drivers and car occupants in different seats (November 2005) shows that:
- in none of the regional capitals seatbelt usage was very good, and in Silesia seatbelt wearing was very good on national roads outside built-up areas,
- in 11 regional capitals and 13 points on rural national roads seatbelt usage was adequate,
- in the other regional capitals (Podlaskie, Lubelskie and Kujawsko-Pomorskie regions) and on two rural national roads (Podkarpackie and Lubelskie regions) seatbelt usage was satisfactory,
- seatbelt wearing improved most over the last two years in the regions of Podlaskie, Slaskie, Podkarpackie, Opolskie and Wielkopolskie.

5. Consequences of seatbelt wearing

The epidemiological approach to road safety treats seatbelts as a barrier, which helps reduce the consequences of an accident. There are four types of barriers [15]:
- intangible barriers (rules, law, restrictions, monitoring),
- symbolic barriers (signs, signals, alarms, procedures, instructions, warnings, etc.),
- functional barriers (codes, locks, spacing, etc.),
- tangible barriers (walls, energy absorbing barriers, seatbelts, airbags, etc.).

Seatbelts are designed to hold the driver and occupant in place in their seats during sudden braking and when hitting an obstacle to neutralise the inertia which moves the human body towards the windshield and the obstacle.

Table 1. Those using seatbelts and road accident fatalities in the United States of America between 1983 and 2004 [16]

<table>
<thead>
<tr>
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<th></th>
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<tbody>
<tr>
<td>USPO</td>
<td>%</td>
<td></td>
<td>14.0</td>
<td>21.0</td>
<td>48.0</td>
<td>69.0</td>
<td>74.5</td>
<td>81.8</td>
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<tr>
<td>LZ</td>
<td>victims</td>
<td></td>
<td>42589</td>
<td>43825</td>
<td>44599</td>
<td>41817</td>
<td>41945</td>
<td>42636</td>
</tr>
<tr>
<td>LZKP</td>
<td>victims</td>
<td></td>
<td>30578</td>
<td>31479</td>
<td>33890</td>
<td>33064</td>
<td>33451</td>
<td>33134</td>
</tr>
<tr>
<td>LZSP</td>
<td>victims</td>
<td></td>
<td>827</td>
<td>2391</td>
<td>6775</td>
<td>10159</td>
<td>11787</td>
<td>13146</td>
</tr>
<tr>
<td>LZNP</td>
<td>victims</td>
<td></td>
<td>23080</td>
<td>22131</td>
<td>22547</td>
<td>19123</td>
<td>17810</td>
<td>16364</td>
</tr>
<tr>
<td>PPO</td>
<td>blnVkm</td>
<td></td>
<td>2067.8</td>
<td>2212.3</td>
<td>2968.0</td>
<td>3433.4</td>
<td>3888.8</td>
<td>4165.3</td>
</tr>
<tr>
<td>WTZSP</td>
<td>ind./1 blnVkm</td>
<td></td>
<td>0.40</td>
<td>1.08</td>
<td>2.28</td>
<td>2.96</td>
<td>3.03</td>
<td>3.16</td>
</tr>
<tr>
<td>WTZNP</td>
<td>ind./1 blnVkm</td>
<td></td>
<td>11.16</td>
<td>10.00</td>
<td>7.60</td>
<td>5.57</td>
<td>4.58</td>
<td>3.93</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>27.91</td>
<td>9.26</td>
<td>3.33</td>
<td>1.88</td>
<td>1.51</td>
<td>1.24</td>
</tr>
</tbody>
</table>
where:
USPO – share of those wearing seatbelts in passenger cars,
LZ – total number of fatalities,
LZKP – number of fatalities among drivers and occupants,
LZSP – number of fatalities in passenger cars and light trucks using restraints,
LZNP – number of fatalities in passenger cars and light trucks not using restraints,
PPO – estimated miles travelled of passenger cars and light trucks annually,
WTZSP – fatalities in passenger cars and light trucks using restraints,
WTZNP – fatalities in passenger cars and light trucks not using restraints,
WRNP – risk of death if driving without the seatbelt on.

Using well documented and aggregated road accident fatality data involving passenger
cars and light trucks in the United States between 1983 and 2004 [16], the risk of being
a casualty in an accident was defined if no restraints were used (mainly seatbelts) – Table
3. The studies show that the lower the seatbelt usage rate is, the higher the risk of death in
a road accident.

The WRNP risk of death if driving without the seatbelt on was calculated as the product
of the transport rate for fatalities when no seatbelts were used and the transport rate for
fatalities using seatbelts.

\[
WRNP = \frac{WTZNP}{WTZSP}
\]  

(2)

The hypothesis was adopted that there is a significant relation between WRNP and the
share of those using seatbelts USP in a population of drivers and car occupants, and that
the relation can be described as:

\[
WRNP = a \times \exp(-b \times USPO)
\]  

(3)

The hypothesis was first tested on a set of aggregated data recorded in the United States
between 1984 and 2004 (Fig. 1) [16].

Fig. 1. The relation between those using seatbelts and the risk of being a fatality in a road accident
among those involved who did not wear seatbelts
The knowledge of how many drivers and car occupants wear seatbelts was used to estimate the number of people who survived car accidents because they were using restraints. In the United States every year an estimation is made of the number of people, who survived accidents because they were using restraints. Between 1975 and 2004 nearly 1.3 million people died in car accidents of which 340,000 could have been saved, if they had had seatbelts on. It was estimated that wearing seatbelts saved about 195,000 lives within this time [16].

Poland’s seatbelt usage study and US data on people who survived accidents (Fig. 2) were the basis for an estimation of the number of drivers and occupants of passenger cars and trucks in Poland, who survived accidents, using this relation:

\[ \text{LOC}_p = \frac{\text{UOC}_a \times \text{LZKP}_p}{100 - \text{UOC}_a} \]  

(4)

where:
- \( p \) – data from Poland,
- \( a \) – data from the United States,
- \( \text{LOC} \) – number of victims saved because they wore a seatbelt,
- \( \text{UOC} \) – share of victims saved because they wore a seatbelt in the United States,
- \( \text{LZKP} \) – number of fatalities among drivers and occupants of passenger cars, trucks and buses in Poland.

\[ \text{UOC}_a = \frac{100 \times \text{LOC}_a}{\text{LZKP}_a + \text{LOC}_a} \]  

(5)

The hypothesis was adopted that the rate of those saved \( \text{UOC} \) depends significantly on the number of those using seatbelts \( \text{USP} \) in a population of drivers and car occupants and that it can be described with this relation:

\[ \text{UOC} = a \times \exp(b \times \text{USP}) \]  

(6)

This hypothesis was tested and confirmed on a set of aggregated data from the US between 1984 and 2004 [16]. As was the case with the risk rate (relation 3), the coefficients of the equation (relation 6) \( a \) and \( b \) depend on: the level of exposure of drivers and car occupants to car accidents, mainly on miles travelled, and the severity of accidents, which mainly depends on the speed and the type of obstacle, which the vehicle hits in an accident.

Our analyses show that between 1990 and 2004 in Poland:
- 98.6 thousand people died in road accidents, of which 44.1 thousand as drivers and occupants of cars and buses,
- seatbelts saved 8.5 thousand lives,
- if within that time at least 95% of road users in vehicles used seatbelts the total of 32.0 thousand road users could have been saved from death, i.e. 42% of the total number of fatalities and people saved within that time.

![Graph showing the relation between those using seatbelts and those saved in a road accident in the United States who wore seatbelts](graph.png)

Fig. 2. The relation between those using seatbelts and those saved in a road accident in the United States who wore seatbelts

### 6. Conclusions

1. Studies, which began in 2002 show that Poland’s seatbelt wearing rates are quite high, but still far from those in Sweden, Canada, Netherlands, United Kingdom or Germany.
2. The results of the seatbelt effectiveness study show that it is one of the least expensive and most effective means of reducing road traffic casualties. Consequently, there should be more preventative efforts to increase the number of road users using seatbelts in populations of drivers and occupants of all motor vehicles.
3. It is recommended that the system for monitoring seatbelt usage should be continued and developed over the years, and more study points should be established with a broader scope of study.
References