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Willingness to Pay for Road Safety Improvements in Poland

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Abstract:

Purpose: *The article presents the results of empirical research on the application of the WTP method in Poland and VSL for Poland for different road users: pedestrians and drivers.*
Design/Methodology/Approach: *An essential instrument for improving road traffic safety is to identify factors determining the behaviour of road users and their willingness to pay (WTP) for reducing the risk of death or injury. The research was conducted on a representative sample of 1085 people using a conjoint analysis. It was preceded by preliminary research using the bulletin board discussion technique for improving the quality of the measuring instrument.*
Findings: *The research allowed for estimating the Value of a Statistical Life (VSL) and determine the profile of behaviour of protected and unprotected road users. The VSL estimate for Poland does not differ significantly from the values determined for other European and non-European countries, but is lowest.*
Practical Implications: *The study provides in-depth knowledge about the socio-economic profile of road users necessary to improve the effectiveness of educational programs in the field of road safety improvement.*
Originality/value: *The VSL research was conducted with an exclusive, two-stage method of using the bulletin board discussion (BBD) technique and the conjoint analysis based on the WTP method*; *This study estimated the Value of Statistical Life in terms of road safety for different road users: pedestrians and drivers in Poland.*

Keywords: *Willingness to pay, value of a statistical life, conjoint analysis, road safety.*

JEL codes: *D11, H52, R41.*

Paper Type: *A research article.*

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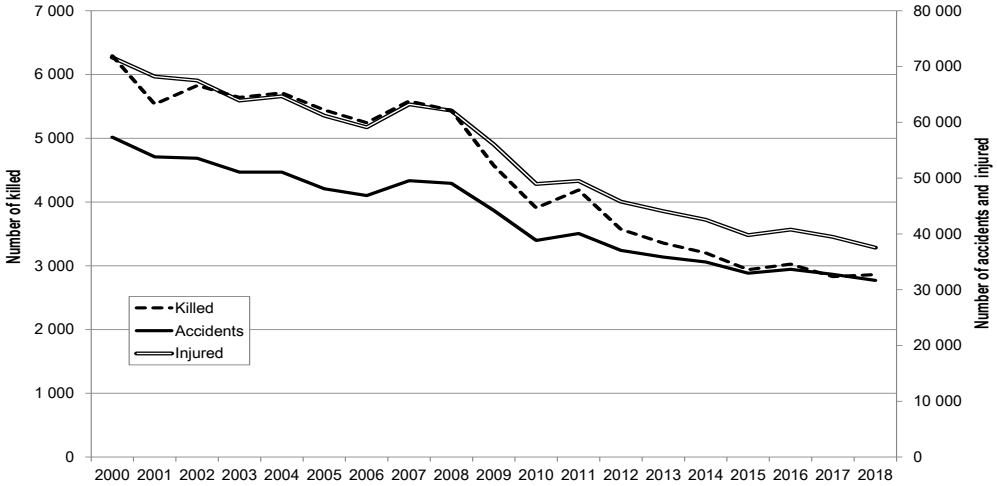
1. Introduction

The dynamic development of the automotive industry generates — in addition to the benefits related to mobility and economic growth — high economic and social costs. Actually, road safety is a one of most important sources of the global hyper mortality and decline in health (IHME, 2015; Demasi, Loprencipe and Moretti, 2018; Santos *et al.*, 2019). The state of road safety violates public and demographic security in the world (WHO, 2018). In addition to personal losses, road accidents are a source of emotional suffering and an extension of the quality of life. The economic costs result mainly from the high risk of road accidents. It is estimated that on average the annual share of the social costs of road accidents ranges from 0.4% to even 4.1% of each country's GDP (Wijnen *et al.*, 2019).

Generally, the state of road safety is a barrier to sustainable social development. In the light of the necessityof principal changes in the formation of the world social and economical policy and building of the society with the expanded capabilities for the self-fulfillment of an educated, healthy and materially secured, the road safety problem is global challenge person (Karpenko *et al.*, 2019).

The mean proportion of the costs that related to road accidents in the structure of the external costs of EU-28 transport is 33%, whereas in Poland – 47% (Pawłowska, 2018). Such a high share of the costs of accidents in Poland is a consequence of a very low level of road safety. Despite efforts to reduce the number of accidents and their consequences, the level of road safety is considered critical. As a result of traffic accidents in Poland, every year about 3 thousand people die (Fig. 1), and more than 37 thousand suffer injuries leading in many cases to the permanent exclusion from participation in the social and economic life.

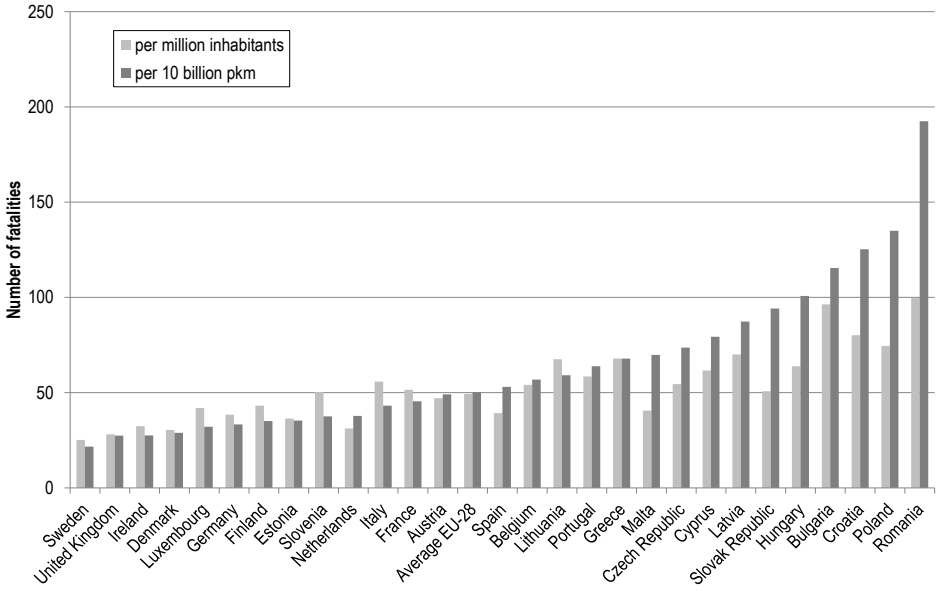
Figure 1. *Number of accidents and fatalities in Poland*



Source: *Own study on the basis (KGP, 2019).*

Despite significant improvements in safety, the risk of death on Polish roads is one of the highest in the European Union (Dyr *et al.*, 2017). In 2017, the number of fatalities counted in road accident was 75 per one million inhabitants and 135 per 10 billion vehicle kilometres. The mean value of the said ratios in EU-28 was 49 per one million inhabitants and 50 per 10 billion vehicle kilometres (Figure 2).

Figure 2. *The road fatalities indicator in EU-28*



Source: *Own study on the basis (European Commission, 2019).*

Recognizing the negative economic and social effects of accidents, the European Commission is taking numerous steps to improve road safety. The observed numbers of people killed or severely injured in road crashes have gradually been reduced in recent years, as a result of traditional safety strategies focusing on safety behaviours, technology, and infrastructure.. These include e.g. improving the system for education and training of road users, improving the enforcement of traffic rules, increasing the safety of road infrastructure and vehicles, promoting the use of modern technologies, improving services in emergency situations and services after injury, as well protecting users of roads particularly vulnerable to accidents (COM 389, 2010). There are, however, still possibilities for further reductions, but it has been argued that this requires the application of new approaches to road safety. For example, the safety culture perspective comprises such a new approach, with a great potential to reduce road accidents, as culture makes up an important risk factor not currently addressed by traditional interventions (Nævestad *et al.*, 2019).

In every action to enhance safety, it is crucial to determine the Value of a Statistical Life (VSL). VSL is not a price of life or the value of preventing the death of one person. Instead, VSL is used in cost-benefit analysis (CBA) as a monetary measure

of the benefits to people from small risk reductions that arise from safety projects (Baker *et al.*, 2009). The Value of a Statistical Life (VSL) is an important input for studies on the socio-economic costs of road crashes. Studies in this field provide relevant information that can be used in educational programmes (Haddak, 2016), including concerning the creation of safety culture (Nielsen, 2014), as well as the creation of a safety management system (Wachter and Yorio, 2014), activities from the scope of the transport policy (Rizzi and Ortúzar, 2006) or the assessment of the investment projects (Jou and Chen, 2015). The willingness to pay (WTP) method is particularly important in the evaluation of the Value of a Statistical Life.

In the transport sector, it is used e.g., for the valuation of external costs *(Ortúzar et al.*, 2000), noise reduction (Fosgerau and Bjorner, 2006), congestion (Mahirah *et al.*, 2015) and travel time (Brownstone *et al.*, 2003), improving the quality of public transport (Eboli and Mazzulla, 2008) or safety in road transport (Andersson, 2007). In this last aspect the research is conducted not only for individual countries, but also selected regions, e.g., Rhône in France (Haddak, 2016) or the Klang Valley in Malaysia (Mahirah *et al.*, 2015), the types of roads, e.g., state highways (Chhotu and Kumar, 2014). The individual willingness to pay for reduce of risk of death in the road traffic can also be taken as a mesure of the effectiveness of road safety education. Road safety education has been recognized as an most important instrument for reducing road accidents. Among young peopleaged15–29 years, road traffic accidents are the leading causes of unintentional injury and death. Road traffic accidents account for approximately 35–40% of the injury-related mortality among teenagers and young adults in Western countries, and are estimated to be the ninth leading cause worldwide for all age groups. Effective educational programs and their evaluation are important (Riaz *et al.*, 2019).

The estimation of the Value of a Statistical Life in transport projects with the application of the willingness to pay method is becoming more and more popular in developed countries (Baker *et al.*, 2009). It provides higher valuations than other methods (Wijnen *et al.*, 2019).

In Poland, in order to estimate the Value of a Statistical Life for the purposes of road transport safety management, researchers use the human capital and restitution costs method (Jaździk-Osmólska, 2015). The willingness to pay research was performed for the first (and still the only) time at the end of 2014. It was financed with the grant "Willingness to Pay (WTP) — examination of the readiness of public participation in the proactive shaping of road safety and the valuation of the costs of accidents and road collisions on the road network in Poland at the end of 2014, along with correlation with the results of the WTP research" funded in the year 2015 by the Secretaryship of the National Road Safety Council at the Ministry of Infrastructure and Construction. A more extensive research was carried out in the form of a doctoral thesis (Jaździk-Osmólska, 2018).

The article presents the results of this empirical research on the application of the WTP method in Poland and VSL for Poland for different road users: pedestrians and drivers. The major objective of the study was to estimate the VSL in the face of danger to life on the road and finally identify the determinants of the willingness to pay for the enhancement of the road transport safety in Poland.

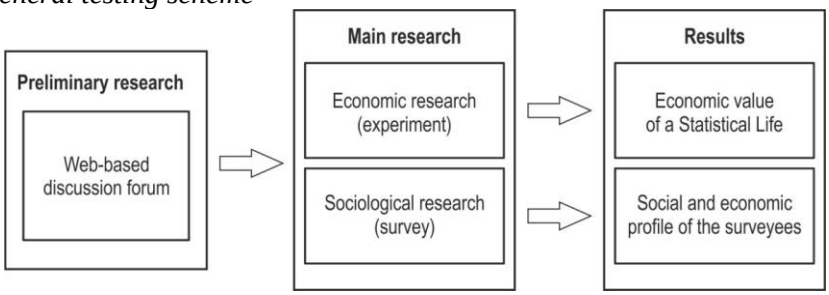
2. Materials end Methods

General Testing Scheme: In the context of road safety, the VSL research was conducted with an exclusive, two-stage method of using the bulletin board discussion (BBD) technique and the conjoint analysis based on the WTP method (Jaździk-Osmólska, 2015). The testing scheme was as follows (Figure 1):

Stage I (preliminary) — qualitative study in the form of a discussion forum using the BBD technique with a group of 30 victims of road accidents and their relatives about the causes and health and socio-economic effects of road accidents.

Stage II (main) was to design a quantitative study, which involved the study of the willingness to pay for reduction of risk in road traffic (WTP research), carried out on a group of respondents representative for Poland (n=1085 people) in the form of sociological survey with an economic experiment (conjoint analysis).

Figure 2. *General testing scheme*



Source: *Own study.*

The need to carry out a qualitative research on the focus group of individuals affected by road accidents stemmed from, above all, the nature of the WTP research, which is a sociological study combined with some elements of an economic experiment. In Poland, there have been no qualitative research on the society in the context of road traffic risk apart from quantitative (questionnaire) studies concentrating on exploring opinions on current problems related to road safety. Only a qualitative research in the form of an open discussion would allow us to analyse one's behaviour, interpretation of a problem, what and why stimulates an individual to take up certain actions, etc.

The results of the qualitative study were used to construe the questionnaire and the economic part of the research. The extended answers of the respondents and their analyses served as a route marker when designing clear and easy to understand

expressions, constructions and types of questions and their sequencing. What is most important, however, they provided valuable information regarding the way in which the issue of road safety is perceived through the prism of personal reflections and became a guideline for the analysis of the present readiness of the community to discuss road safety. The respondents indicated crucial areas and solutions associated with the financing and expectations towards the provision of safety in road traffic.

Bulletin Board Discussion: As a method allowing one to ensure mental comfort to individuals participating in the discussion and to guarantee reliability of the results, an internet discussion forum was selected using the Bulletin Board Discussion (BBD) method. The BBD study was conducted in two discussion groups:

- A group of victims of road accidents from around Poland, adults over 18 years of age, of both sexes, both city and country dwellers;
- A group of family members of road accident victims.

CAPI-in home system: The survey was conducted using the *CAPI-in home* system. in respondents' households. The study was performed on an all-Poland random-quota population with randomly selected start addresses. In order to obtain a reflection of the demographic structure of the Polish residents in the study, the so-called quotas for respondents' age and gender were attached. The implementation of the underlying research was preceded by a pilot study aimed at detailing and perfecting the research tool. The study was conducted on a sample population of adult Poles aged 18 to 75. Four respondent cohorts were distinguished: 18-29, 30-44, 45-59, 60-75 years old. In order to ensure representativeness of the sample, it was stratified into provinces (*województwa*) and 9 classes of sizes of the place of residence according to the Central Statistical Office (*GUS*). The average duration of the study interview, composed of a sociological study and an economic experiment, per one individual did not exceed 45 minutes.

Marginal rate of substitution analysis: In the context of road safety, the *marginal rate of substitution* (MRS) is defined between the goods expressed in monetary form, and the risk of being a fatal victim or injured in a road traffic accident (Rizzi and Ortúzar, 2006). The MRS analysis is based on a random utility function, which assumes that the user of the goods experiences subjective satisfaction known as utility. The utility of the goods, which is one of the basic concepts of the economics theory, means such its characteristics which in the circumstances given are able to meet the current needs and expectations of the goods (Stiglitz, 2000). Theoretical basis of human life value in the context of road safety has been the subject of numerous publications, for example: (Rizzi and Ortúzar, 2006). Therefore, this article omits their presentation by focusing on these methodological assumptions that are necessary to achieve the objective pursued.

Conjoint analysis: In order to measure the preferences of respondents regarding road safety, conjoint analysis derived from the *conjoint measurement theory* (CMT)

was used. This theory, first described in 1964, (Luce and Tukey, 1964), allows for evaluation of a group of features connected in a profile of the studied goods using the interval scale. The respondents rate the profile of the subject of the study, described with specific attributes. The profiles consist of a specific and fixed number of attributes, and differ only in their levels. Evaluation of profiles by the respondents involves reconciliation with compromise. The respondent shall make multiple choices between profiles, every time taking a decision on how much of a given attribute they are willing to sacrifice to get the part of another attribute.

The main task of the respondents in the main study was to select their preferred travel type (i.e. the most typical, frequent, in or outside of town) out of different hypothetical scenarios of travel routes. Two types of scenarios were developed as part of the research, i.e. for the group of protected (drivers) and separately unprotected (pedestrians) road users. Each of the selection options was described with the same number of attributes assigned to the type of hypothetical travel. Selection of the types of attributes was corresponded to the indicators of satisfaction with travel based on results of national survey (Komornicki, 2007), separately for drivers and pedestrians, which allowed to assess the respondents' preferences in relation to the presented attributes. Each interview was preceded by a short introduction concerning the scope of the study, its purpose and the bodies in charge of the research. The breakdown of used attributes is contained in Tables 1 and 2.

Table 1. *Types of attributes and their levels in the group of drivers*

Attributes	**Attribute level**
Travel time [minutes]	5; 10; 15; 20; 30; 40; 60; 80; 90; 120
Route length [km]	5; 10; 15; 40; 60; 80;
Number of fatalities	0; 1; 2; 3;
Number of victims seriously injured	0; 1; 2; 3;
Number of victims slightly injured	0; 1; 2; 3; 4; 5;
Travel cost [PLN]	min. 0; max. 11.75

Source: *Own study.*

Table *Σφάλμα! Δεν υπάρχει κείμενο καθορισμένου στυλ στο έγγραφο.***.** *Types of attributes and their levels in the group of pedestrians*

Attributes	**Attribute level**
waiting time for crossing [minutes]	0; 1; 2–3; 4–5; above 5;
distance from the crossing [m]	less than 50; 50–100; 100–150; 150–200;
number of fatalities	0; 1; 2;
number of victims seriously injured	0; 1; 2; 3;
number of victims slightly injured	0; 1; 2; 3; 4;
crossing cost [PLN]	min. 0; max. 8.25

Source: *Own study.*

The respondents reviewed profiles (consisting of attributes) of a hypothetical travel on the basis of choices between several profiles (*Choice-Based Conjoint*). A specialized Sawtooth Software package (version 8.4.4) dedicated to the computer-based support for the surveying systems was used as a tool for implementation of the conjoint analysis. From amongst the traditional modules for conducting the choice-based conjoint analysis preferred by the Sawtooth software, it was decided to use the new system for obtaining the preferences of the respondent — *Adaptive Choice-based Conjoint Analysis* (ACBC). The main justification for the choice of the ACBC algorithm was the ability to use the adaptive method of discrete choices, which allows to focus on profiles (levels and attributes) actually relevant to the respondent (Johnson *et al.*, 2005).

The behaviour of the algorithm is reflected in the dynamic implementation of the experiment and an innovative questionnaire, which makes the research less tedious, involves the respondents who, in effect, make more informed choices. During the interview using the ACBC algorithm, the respondent is not forced to perform a series of monotonous and difficult profile choice tasks. An important part of the algorithm is to *build your own configurator (BYO module)*, which provides an interactive process of creating the profiles.

To this end, additional features describing a hypothetical trip were introduced, thanks to which a scenario of a trip most similar to the one a given respondent made every day could be developed. The selection scenario in the group of drivers included a trip by car in various land development areas (build-up/non-built-up, in the city/bypass). In the case of the second group, the selection situation concerned the hypothetical crossing through a carriageway under land development conditions, at different road sections (single/dual carriageway road). It allows the respondent to define the optimum profile which produced that way is a starting point to determine the shape of the next profiles presented in the following steps. This step allows for specifying the main rules the respondent uses, because the respondent's answers are analysed on an on-going basis, and this allows for capturing the mandatory levels of attributes and levels unacceptable.

During research, questions are constantly asked about whether any of the presented levels of attributes is absolutely unacceptable or if any of the presented levels of attributes is required. However, the questions asked do not apply to all levels of attributes, but only those most commonly selected. The ACBC algorithm assumes that presentation of an alternative choice, which the respondent certainly will choose or will not choose, has no value. Most information is carried by alternatives with a medium probability of selection. If options from the previous selection included alternatives with an extremely likely probability of selection, the ACBC algorithm presents these alternatives or similar ones (Johnson *et al.*, 2005). The procedure of the conjoint analysis conducted as part of the VSL research was as follows:

- In the first part of the interview („Build Your Own" module), the respondents were asked to indicate their preferred level of each travel attribute.
- In the second part, the surveyee was presented a sequence of screens on which the hypothetical concepts of travel were shown a few at a time. Then it was checked whether there are levels of parameters that are not compensated by the presence of other desired qualities. If the scenarios that were marked by the respondent as acceptable had a certain level of attribute (or a range of levels of attributes), the respondent was asked if this is a mandatory feature of their preferred travel type.
- In the third part of the research was a kind of a competition between the options, of which the scenarios previously considered acceptable were constructed.

An important premise adopted during the implementation of the experiment was that one of the possible options of choice has always been the *status quo* scenario. Its selection was related to not incurring any travel costs (PLN 0). Selection scenarios were presented in electronic form. Each of the respondents received 30 choice scenarios which were a combination of all the attributes at different levels of their values. The number of all possible combinations of options in the group of evaluated drivers was 1152, and 5048 for pedestrians.

To estimate the parameters of the utility function, the Multinomial Logit (MNL), belonging to the group of models of discrete choices with unordered alternatives was used, whose task is to represent the distribution of preferences and allow for predicting the likely choices of potential consumers of analysed goods. While using models of discrete choices, it is possible to estimate the likelihood that the respondent *i* selects alternative *j* (Baltas and Doyle, 2001). Application of the polynomial logit model allows for estimating not only the expected values of the individual usabilities, but also the variation between answers of the respondents (Train, 2009). The probability of selection can be defined using the following formula:

$$P_{ij} = \frac{\exp(\beta_j s_i)}{\sum_{k=1}^{J} \exp(\beta_k s_i)} \tag{1}$$

where:
P_{ij} — probability that person i selects alternative j,
J — number of all alternatives;
β_j — vector characterizing the j-th alternative;
s_i — vector characterizing the i-th respondent.

The marginal rate of substitution (MRS) can be calculated as:

$$MRS = WTP_{ind} = \frac{\beta_{Z,CR,LR}}{\beta_c} \tag{2}$$

Where, $\beta_Z, \beta_{CR}, \beta_{LR}, \beta_c c_{ij}, \beta_t$ are the estimation model results regard to levels of all attributes.

With the adopted assumptions, the Value of a Statistical Life is:

$$VSL = \frac{WTP_d^{soc}}{\delta r_d} \tag{3}$$

and the Value of Statistical Injury

$$VSI = \frac{WTP_i^{soc}}{\delta r_i} \tag{4}$$

where:
WTP_d^{soc} – social, with willingness to pay for reduction by 1 fatality,
WTP_i^{soc} – social, with willingness to pay for reduction by 1 injured,
δr_d – change in the level of risk of being a fatality,
δr_i – change in the level of risk of being an injured victim.

The change of the individual risk for each road user, for the specific type of travel by a road with a specific length was expressed with the formula:

$$\delta r = \frac{NV^{befor} - NV^{after}}{ADT \cdot 365} \tag{5}$$

Where:
NV^{before} – is the number of victims per year before risk reduction,
Nv^{after} – is the number of victims per year after risk reduction,
ADT – is the average daily traffic by roads within a year.

In order to estimate the economic value of one statistical human life or one injured victim, equation 7 was transformed into the following one:

$$r = \frac{1}{ADT \cdot 365} \tag{6}$$

and equation 5 as:

$$VSL = WTP_{rd}^{soc} \cdot ADT \cdot 365 \tag{7}$$

Where WTP_{rd}^{soc} — rate of substitution (willingness to pay) between the cost of the travel and reduction of risk by one fatality. Similarly, equation 6 took the following form:

$$VSI = WTP_{ri}^{soc} \cdot ADT \cdot 365 \tag{8}$$

Additionally, it was assumed that:

- The value of social willingness to pay for risk reduction is the average or a median of individual rates of substitution of road users.
- Estimation of *VSL* values should be differentiated with respect to levels of aggregation of the individual WTP_{ind} value and risk levels in different traffic conditions, such as the type of area development, the section of the road, and, in particular, the level of risk of road users.

The individual willingness to pay for reduction of WTP_{ind} risk of being a fatal victim has been aggregated to the level of the social value of the substitution rate by:
groups of road users;

- type of area development (in the tested group of drivers);
  road section;
- type of pedestrian crossing (in the tested group of pedestrians).

Having regard to the presented assumptions, the VSL of protected road users (D-drivers) is:

$$VSL_{l,p}^{soc,D} = wtp_{l,p}^{soc,D} \cdot ADT \cdot 365 \tag{9}$$

and unprotected road users (P-pedestrians):

$$VSL_{r,p}^{soc,P} = wtp_{r,p}^{soc,D} \cdot ADT \cdot 365 \tag{10}$$

where:
l – location of the road relative to the built-up area *1, 2,…l*;
p – road section *1, 2,…p*;
r – type of pedestrian crossing *1,2,…r*;

3. Results

The BBD qualitative research covered 30 people, including 15 victims of road accidents and 15 members of families of road accident victims. One thousand and eighty-five (1085) people participated in the survey, 574 women and 511 men, recruited to two groups of road traffic participants: drivers and pedestrians (also cyclists), based on their stated method participation. Among the female participants, 291 declared to be either drivers or passengers, and 283 claimed to mostly go on foot or cycle. As far as the males are concerned, 256 belonged to the driver group, and 255 to the pedestrian one. All study subjects, both women and men, were between 18 and 75 years old in accordance with the research assumptions, and the structure of their age corresponded to the age structure observed in the Polish population. The remaining principal socio-economic characteristics of the study population were as follows:

- the majority of the rural dwellers were pedestrians, whereas most urban dwellers (residents of cities with a population of over 100 thousand) drove;
- irrespective of the gender of the respondents, 61% were in a permanent relationship, and 39% lived alone[2];
- the majority of the respondents (65%) had children[3];
- drivers' households were most numerous than in the case of the pedestrians: 30% had a three-member households (25% in the group of pedestrians), 26% – two-member households (32% in the group of pedestrians) and 27% – four-member households (21% in the group of pedestrians);
- nearly 75% of the drivers declared they had a permanent job. The group of pedestrians comprised significantly less individuals with a stable professional situation – only 55% and 24% pensioners (13% in the group of drivers);
- with respect to financial standing, the majority of the study drivers and pedestrians (65% and 66%) declared to have sufficient means to conduct everyday lives, but more serious expenses were difficult to cope with.

On the basis of the results of the BBD study, we can say that both groups are sensitized to issues and difficulties relating to road safety, but the interviews reveal that it is still a long way from full awareness. This is particularly true in the context

[2]*This included 26% of single persons, 8% widowed, and 5% divorced or separated.*
[3]*forty-three (43%) of the indications regarded having offspring aged 25 and more, and 21% - children aged 7 to 12 and 19 to 24.*

of the categories of the reasons behind accidents, risk factors, costs related to safety, and correlations between various categories. The majority of the pedestrians participating in the forum blamed them for causing the accidents, whereas, in most cases, the drivers were the ones accountable. What is also crucial is that the study pedestrians who participated in road incidents caused by drivers felt co-responsible. Yet another important factor is alcohol use. The stories cited included no accidents caused by drunk drivers.

However, the problem of drunk drivers was graded as the most significant by the respondents. It appears that, when discussing the scale of the issue, the speakers tend to refer to the media rather than their own experience. The next problem which all forum's participants focused on was the age and health condition of the drivers. Interestingly, elderly drivers (despite their lifelong experience and knowledge of own limitations) raised more concerns than young drivers with short driving experience and a lot of pride in themselves. Another issue raised by the forum participants was the use of stimulants and drugs slowing reactions. It was generally stressed by the respondents who often associated it with the age of road traffic participants. The emotional condition of traffic participants was a clearly underlined issue, especially in the victim group. Without a doubt, the discussions demonstrate that the surveyees were aware of the fact that drivers made bad decisions when emotional stimuli, such as aggression, was at play. Both speeding and bravado appeared relatively frequently as the causes of and the factors increasing the risk of accidents.

Another factor mentioned by interlocutors was maladjustment of speed to road traffic conditions, unfavourable weather conditions, poor vehicle condition and insufficient driver training. It appears that perception of the role of the government is subject to one's personal experience. The study subjects specified the areas of state actions – from prevention through more severe penalties (higher tickets, taking away driving licenses, especially for drunk driving) to education (victims' families). A strategic element enhancing road safety according to the respondents is road infrastructure development. Forum participants believe that the condition of the roads in Poland is very bad and without taking actions in this field, road safety cannot improve. Among a number of activities, the studied population postulate to remove constitutional immunity, increase roadside inspection frequency, and run social campaigns. They believe that the role of non-governmental organizations should be to manage social campaigns, support accident victims free of charge and finance road construction.

The majority of the surveyees draw attention to the changes in the perception of road traffic: they specify in particular a decrease in road trust, an increase in attentiveness, limitations in car use, talking to family and friends (relating to one's own experience). Nonetheless, a part of the respondents say that accident-derived experience has not in any way contributed to their behaviour on the road or personal views on road traffic.

Among the sources of financing road safety improvements, the respondents specify, above all, state budget funding, EU funds, and taxes. There also mention ideas relating to third-party insurance, taxing foreign hypermarkets, punishing offenders and using some part of the ticket money. The study subjects want to use the funds to in road investments, maintenance and modernization of the existing roads, improvement of street lighting and Police services.

The result of the conducted conjoint analysis were the utility values of the individual attribute levels assessed using a multinomial logit model. On this basis, the individual willingness to pay for a reduction in the levels of the selected attributes was determined for each respondent, separately in the group of drivers and pedestrians. On the basis of the surveyee's preferences regarding the type of travel designated by using the individual values of utility of the attribute levels, the next subgroups of respondents were isolated in each of the two basic groups. In the group of drivers, these were four subgroups according to the following daily travel conditions:

- Preferred route: non-built-up area, collision road.
- Preferred route: non-built-up area, collision-free road.
- Preferred route: built-up area, city.
- Preferred route: built-up area, bypass.

Two subgroups of daily conditions concerning travel were isolated in the group of people moving on foot:

- Preferred crossing through a single carriageway road.
- Preferred crossing through a dual-carriageway road.

The results are presented in Tables 2-4. The detailed analysis points to the significant diversity of preferences among the respondents. The assessed utility function parameters may be interpreted only with respect to the sign whether a given attribute has a positive or a negative effect on the level of utility attained. Direct interpretation of the parameters due to the power of their effect is impossible for each has an effect with an unknown scale parameter. Direct comparability allows one to estimate the marginal willingness to pay (WTP) for individual features. In addition, WTP interpretation expressed in monetary units is more direct than interpretation of the utility function parameters.

All attributes of road safety take on the signs in accordance with expectations: utility drops as the number of victims on the roads increases, whereas the willingness to pay for risk reduction of becoming a road accident victim varies. Drivers using collision roads and bypasses on everyday basis are most willing to pay for the reduction of the risk of becoming a road accident fatality from level 1 to level 0 (PLN 5.66 and PLN 5.22, respectively). In the event of those who prefer driving in the city, it is somewhat less (PLN 4.0), and it is twice less in the case of drivers

using collision-free roads (PLN 2.17). Among pedestrians, the willingness to pay for the reduction of the risk of death as a result of a road accident at a pedestrian crossing was much lower, ca. PLN 2.00 in the group of pedestrians crossing a single carriageway, and PLN 2.65 in the group crossing a dual carriageway.

As far as the remaining attributes are concerned, the results are more differentiated. The utility of the route among drivers preferring out-of-town routes is growing with trip duration and distance. This means that the respondents prefer longer trips out of town. In the case of individuals driving in the city every day, it is quite the opposite – the shorter the route and travelling time, the higher the utility. Moreover, with reference to the distance parameter, it can be observed that the most willing to pay are the drivers which declare the city bypass to be the shortest trip (PLN 2.86), and the least willing are those who believe that the collision-free road is the shortest one.

However, they declare they are willing to pay more with respect to the trip duration parameter. Drivers are willing to pay most for a 5km-trip by a city bypass (PLN 6.83) and least for a 30-minute trip in the city (PLN 2.96). It may be concluded that the studied drivers value their road safety significantly, and some of the value it more than all other attributes (the group of drivers travelling on collision-free roads and in the city). In the event of individuals driving on collision-free roads and bypasses, the most appreciated attribute of the preferred trip turns out to be the time (duration). Pedestrians who value their safety the most are most willing to pay for a short waiting time (PLN 1.61) and least for the shortest distance between them and the crossing (PLN 0.95). In turn, for pedestrians choosing a two-stage crossing, a short waiting period is the most useful. These respondents are willing to pay PLN 3.00 for the shortest waiting time. PLN 2.65 for safety, and PLN 1.47 (the least) for the shortest distance to the nearest crossing.

The estimated society's final willingness to pay for reduction of the risk by 1 victim presented in Tables 3-5 was used for economic valuation of average VSL values per one trip by car or travel on foot, according to the algorithms presented in the methodological assumptions. The average economic value of human life VSL in the group of pedestrians is PLN 4.4 million (USD 1.19 million). In the group of drivers, the VSL is:

- non-built-up area — PLN 7.2 million (USD 1.95 million),
- built-up area — PLN 5.8 million (USD 1,57 million).

4. Discussion

This study estimated the Value of Statistical Life in terms of road safety for different road users: pedestrians and drivers in Poland. This study was based on the stated preference method. Respondents were asked their WTP to avoid diverse consequences of a road accident. The monetary quantification of profits associated with road safety measures was for a long time limited to the valuation of the number

of avoided deaths. An important part of the literature focused on the estimation of the WTP for a reduction of the risk of fatal accident and on the calculation of the value or the price of the risk, more collectively named as "the value of a statistical life" (Hensher *et al.*, 2009; Veisten *et al.*, 2013). This study, as a first in Poland, is interested in the individual WTP for improve road safety.

Table 3. *Statistics of utility of the surveyees and the willingness to pay for drivers preferring driving in non-built-up area via a collision/collision-free road*

Attribute	Utility (standard error)	WTP (standard error)	Attribute	Utility (standard error)	WTP (standard error)
Group of drivers daily drive in non-built-up area via a collision road			**Group of drivers daily drive in non-built-up area via a collision-free road**		
Route lenght 40 km	0.5976 (0.0848)	1.33 (0.19)	Route lenght 40 km	0.3572 (0.0354)	0.54 (0.05)
Route lenght 60 km	0.6744 (0.1040)	1.50 (0.23)	Route lenght 60 km	0.9079 (0.0491)	1.38 (0.07)
Route lenght 80 km	0.9687 (0.1208)	2.16 (0.27)	Route lenght 80 km	1.2564 (0.0644)	1.91 (0.10)
Travel time 60 minutes	1.6999 (0.1647)	3.79 (0.37)	Travel time 40 minutes	2.0024 (0.0783)	3.05 (0.12)
Travel time 90 minutes	1.7767 (0.1851)	3.96 (0.41)	Travel time 60 minutes	2.5531 (0.0986)	3.89 (0.15)
Travel time 120 minutes	2.0710 (0.2028)	4.62 (0.45)	Travel time 80 minutes	2.9016 (0.0013)	4.42 (0.17)
Number of fatalities 0	2.5397 (0.3105)	5.66 (0.69)	Number of fatalities 0	1.4262 (0.0711)	2.17 (0.11)
Number of fatalities 1	0.6629 (0.1050)	1.48 (0.23)	Number of fatalities 1	0.3699 (0.0266)	0.56 (0.04)
Number of fatalities 2	-1.0455 (0.1610)	-2.33 (0.36)	Number of fatalities 2	-0.5335 (0.0349)	-0.81 (0.05)
Number of fatalities 3	-2.1571 (0.2108)	-4.81 (0.47)	Number of fatalities 3	-1.2626 (0.0552)	-1.92 (0.08)
Number of seriously injured 0	1.0618 (0.1190)	2.37 (0.27)	Number of seriously injured 0	0.6999 (0.0260)	1.07 (0.04)
Number of seriously injured 1	0.2092 (0.0400)	0.47 (0.09)	Number of seriously injured 1	0.2016 (0.0117)	0.31 (0.02)
Number of seriously injured 2	-0.4420 (0.0434)	-0.99 (0.10)	Number of seriously injured 2	-0.2474 (0.0119)	-0.38 (0.02)
Number of seriously injured 3	-0.8290 (0.0868)	-1.85 (0.19)	Number of seriously injured 3	-0.6541 (0.0248)	-1.00 (0.04)
Number of slighty injured 0	0.9113 (0.0478)	2.03 (0.11)	Number of slighty injured 0	0.7554 (0.0123)	1.15 (0.02)
Number of slighty injured 1	0.4036 (0.0171)	0.90 (0.04)	Number of slighty injured 1	0.3949 (0.0076)	0.60 (0.01)
Number of slighty injured 2	0.1142 (0.0136)	0.25 (0.03)	Number of slighty injured 2	0.1065 (0.0062)	0.16 (0.01)
Number of slighty injured 3	-0.1901 (0.0129)	-0.42 (0.03)	Number of slighty injured 3	-0.1815 (0.0047)	-0.28 (0.01)
Number of slighty injured 4	-0.5012 (0.0276)	-1.12 (0.06)	Number of slighty injured 4	-0.4445 (0.0095)	-0.68 (0.01)
Number of slighty injured 5	-0.7378 (0.0382)	-1.65 (0.09)	Number of slighty injured 5	-0.6308 (0.0128)	-0.96 (0.01)
Cost	-0.4484 (0.0775)		Cost	-0.6567 (0.0334)	

Source: *Own study.*

My study broaches this theme in a more general way than the previous works in other countries. First, the conducted discussion forum provides an interesting insight into the way road safety is viewed and, above all, the need to feel safe and its subjective evaluation. Previous works were limited to the survey, without in-depth interviews with accident victims (Iragüen and De Dios Ortúzar, 2004; Hensher *et al.*, 2011; Haddak, Lefèvre and Havet, 2016). Although the small study population does not allow the author to translate the conclusions made into a larger population of Poles, the discussion confirms both the presence of certain stereotypes and the influence of experience on one's approach to the issue, and demonstrates the broad social spectrum of the issue.

Table 4. *Statistics of utility of the surveyees and the willingness to pay for drivers preferring driving in in built-up area in a city/via a bypass*

Attribute	Utility (standard error)	WTP (standard error)	Attribute	Utility (standard error)	WTP (standard error)
Group of drivers daily drive in built-up in a city			**Group of drivers daily drive in built-up via a bypass**		
Route lenght 5 km	0.8509 (0.1148)	1.45 (0.20)	Route lenght 5 km	1.0881 (0.1260)	2.86 (0.33)
Route lenght 10 km	0.8259 (0.0742)	1.41 (0.13)	Route lenght 10 km	0.9457 (0.0800)	2.48 (0.21)
Route lenght 15 km	0.5687 (0.0655)	0.97 (0.11)	Route lenght 15 km	0.7999 (0.0663)	2.10 (0.17)
Travel time 10 minutes	2.0214 (0.1785)	3.44 (0.30)	Travel time 5 minutes	2.6027 (0.2093)	6.83 (0.55)
Travel time 20 minutes	1.9963 (0.1387)	3.40 (0.24)	Travel time 10 minutes	2.4603 (0.1635)	6.46 (0.43)
Travel time 30 minutes	1.7392 (0.1257)	2.96 (0.21)	Travel time 15 minutes	2.3145 (0.1494)	6.08 (0.39)
Number of fatalities 0	2.3544 (0.1900)	4.01 (0.32)	Number of fatalities 0	1.9881 (0.1564)	5.22 (0.41)
Number of fatalities 1	0.5560 (0.0576)	0.95 (0.10)	Number of fatalities 1	0.2776 (0.0352)	0.73 (0.09)
Number of fatalities 2	-1.0386 (0.0943)	-1.77 (0.16)	Number of fatalities 2	-0.8141 (0.0635)	-2.14 (0.17)
Number of fatalities 3	-1.8719 (0.1177)	-3.18 (0.20)	Number of fatalities 3	-1.4516 (0.0938)	-3.81 (0.25)
Number of seriously injured 0	0.9087 (0.0670)	1.55 (0.11)	Number of seriously injured 0	0.9261 (0.0689)	2.43 (0.18)
Number of seriously injured 1	0.2245 (0.0262)	0.38 (0.04)	Number of seriously injured 1	0.1502 (0.0210)	0.39 (0.06)
Number of seriously injured 2	-0.2986 (0.0269)	-0.51 (0.05)	Number of seriously injured 2	-0.2865 (0.0263)	-0.75 (0.07)
Number of seriously injured 3	-0.8347 (0.0481)	-1.42 (0.08)	Number of seriously injured 3	-0.7898 (0.0459)	-2.07 (0.12)
Number of slighty injured 0	0.8437 (0.0309)	1.44 (0.05)	Number of slighty injured 0	0.8289 (0.0289)	2.18 (0.08)
Number of slighty injured 1	0.3888 (0.0133)	0.66 (0.02)	Number of slighty injured 1	0.4117 (0.0141)	1.08 (0.04)
Number of slighty injured 2	0.1532 (0.0129)	0.26 (0.02)	Number of slighty injured 2	0.1693 (0.0136)	0.44 (0.04)
Number of slighty injured 3	-0.1571 (0.0111)	0.27 (0.02)	Number of slighty injured 3	-0.1699 (0.0100)	-0.45 (0.03)
Number of slighty injured 4	-0.4843 (0.0193)	-0.82 (0.03)	Number of slighty injured 4	-0.5198 (0.0205)	-1.36 (0.05)
Number of slighty injured 5	-0.7443 (0.0279)	-.27 (0.05)	Number of slighty injured 5	-0.7202 (0.0273)	-1.89 (0.07)
Cost	0.5878 (0.0574)		Cost	0.3809 (0.0387)	

Source: *Own study.*

On the basis of the BBD study, we may state that the levels of knowledge and understanding of the issues related to road safety in both study groups were higher than the average observed in the Polish population. However, this insight remains unstructured and lacks understanding of the causal relationships. Both groups are sensitive to the issues and difficulties relating to road safety, but the conducted talks reveal that it is still a long way from full awareness. This is particularly true in the context of the categories of the reasons of accidents, the risk factors, costs related to safety, and dependencies between various categories.

Author recommends a greater scale qualitative research with a study population of accident victims and their families and friends in order to gain more insight into accident victims' attitudes to safety and to manage an effective state policy of support to the aggrieved parties.

It seems, that previous works were limited to the specific population, too. For example, the research participants were young drivers, or drivers only or pedestrians (Lahatte, Lassarre and Rozan, 2006; Hensher *et al.*, 2011). My survey was conducted on a sample population of adult Poles aged 18 to 75. Four respondent cohorts were distinguished: 18-29, 30-44, 45-59, 60-75 years old. Participants were divided into two research groups: drivers and pedestrians. As in the other works,

Poles surveyees were asked to choose among different choices of route for a particular trip (Hensher *et al.*, 2009; Haddak, Lefèvre and Havet, 2016).

Table 5. *Statistics of utility of the surveyees and willingness to pay for pedestrians preferring crossing a single/dual carriageway road*

Attribute	Utility (standard error)	WTP (standard	Attribute	Utility (standard error)	WTP (standard
Group of pedestrians daily cross a single carriageway road			**Group of pedestrians daily cross a dual carriageway road**		
Distance from the crossing up to 50 m	0.6540 (0.0357)	0.95 (0.05)	Distance from the crossing up to 50 m	0.7259 (0.0279)	1.47 (0.06)
Distance from the crossing 50 - 100 m	0.2209 (0.0208)	0.32 (0.03)	Distance from the crossing 50 - 100 m	0.2327 (0.0140)	0.47 (0.03)
Distance from the crossing 100 - 150 m	-0.2171 (0.0190)	-0.31 (0.03)	Distance from the crossing 100 - 150 m	-0.1927 (0.0114)	-0.39 (0.02)
Distance from the crossing 150 - 200 m	-0.6578 (0.0373)	-0.95 (0.05)	Distance from the crossing 150 - 200 m	-0.7658 (0.0326)	-1.55 (0.07)
Waiting time for crossing the street 0 min	1.1135 (0.0497)	1.61 (0.07)	Waiting time for crossing the street 0 min	1.4829 (0.0516)	3.01 (0.10)
Waiting time for crossing the street ca.1 min	0.6515 (0.0441)	0.94 (0.06)	Waiting time for crossing the street ca.1 min	1.0521 (0.0476)	2.13 (0.10)
Waiting time for crossing the street ca. 2-3 min	0.0714 (0.0272)	0.10 (0.04)	Waiting time for crossing the street ca. 2-3 min	0.2330 (0.0211)	0.47 (0.04)
Waiting time for crossing the street ca. 4-5 min	-0.7582 (0.0497)	-1.10 (0.07)	Waiting time for crossing the street ca. 4-5 min	-1.1743 (0.0541)	-2.38 (0.11)
Waiting time for crossing the street above 5 min	-1.0781 (0.0580)	-1.56 (0.08)	Waiting time for crossing the street above 5 min	-1.5937 (0.0576)	-3.23 (0.12)
Number of fatalities 0	1.4226 (0.1423)	2.06 (0.21)	Number of fatalities 0	1.3058 (0.0709)	2.65 (0.14)
Number of fatalities 1	-0.2303 ('0.0572)	-0.33 (0.08)	Number of fatalities 1	-0.1460 (0.0297)	-0.30 (0.06)
Number of fatalities 2	-1.1923 ('0.0970)	-1.73 (0.14)	Number of fatalities 2	-1.1598 (0.0514)	-2.35 (0.10)
Number of seriously injured 0	0.9135 (0.0727)	1.32 (0.11)	Number of seriously injured 0	0.9999 (0.0438)	2.03 (0.09)
Number of seriously injured 1	0.1835 (0.0211)	0.27 (0.03)	Number of seriously injured 1	0.1469 (0.0124)	0.30 (0.03)
Number of seriously injured 2	-0.3668 ('0.0280)	-0.53 (0.04)	Number of seriously injured 2	-0.3785 (0.0166)	-0.77 (0.03)
Number of seriously injured 3	-0.7302 ('0.0470)	-1.06 (0.07)	Number of seriously injured 3	-0.7683 (0.0265)	-1.56 (0.05)
Number of slighty injured 0	0.6860 (0.0362)	0.99 (0.05)	Number of slighty injured 0	0.8027 (0.0262)	1.63 (0.05)
Number of slighty injured 1	0.2673 (0.0100)	0.39 (0.01)	Number of slighty injured 1	0.2730 (0.0070)	0.55 (0.01)
Number of slighty injured 2	-0.0990 (0.0125)	-0.14 (0.02)	Number of slighty injured 2	-0.1100 (0.0090)	-0.22 (0.02)
Number of slighty injured 3	-0.3146 ('0.0149)	-0.46 (0.02)	Number of slighty injured 3	-0.3266 (0.0100)	-0.66 (0.02)
Number of slighty injured 4	-0.5397 ('0.0163)	-0.78 (0.02)	Number of slighty injured 4	-0.6392 (0.0120)	-1.30 (0.02)
Cost	-0.6901 (0.0531)		Cost	-0.4931 (0.0277)	

Source: *Own study.*

The individual choices allowed to observe the making choices between different attribute level bundles and to estimate the WTP of the subjects for a reduction of their risk of fatal accident and not mortal injuries. The study showed that the average WTP is higher for mortal wounds than non-mortal ones. Moreover, a hierarchy in the levels of WTP is observed between the various levels of injuries gravity: permanent injuries requiring hospitalization and engendering irreversible consequences present a WTP superior to major or minors injuries without impairment.

The surveyees were willing to pay for reducing the number of fatalities more than four times more than for reducing the number of victims slightly injured and more than double than in the case of the possibility of reducing the number of victims seriously injured.

The average propensity to pay for risk reduction in the group of protected road users is about twice higher than in the group of pedestrians. It should be noted that this difference may be partly due to a lower level of cost attribute value which is

assumed in the model group of pedestrians. Despite this, the mean estimates between the groups of road users in built-up areas are not large. The results of the Polish study both confirmed and highlighted several phenomena.

First, the most considerable one certainly remains the significant impact of the injuries gravity on the WTP. This last one increases with the gravity of the injuries likely to be incurred. The individuals are more ready to invest and grant to pay more important amounts of money to reduce their risk of heavy injuries in comparison to minor and moderate ones. These results follow on from previous studies and confirm the necessity to take into account the level of gravity of injuries in studies of valuation of non-mortal consequences of traffic accidents.

Second, as so far GDP has been the main determinant of the willingness to pay for reducing the risk of road safety (McMahon and Dahdah, 2008). Based on the results of survey in Poland, it can conducted that the value of a statusticcal life in road safety contects depends from our "transportation lifestyle" during daily travels (type of road, built-up and non built-up area nad our position on the road – protected or unprotected). In terms of specific preferences of the surveyees, it has been observed that:

- the persons tested, driving mostly in built-up areas, were ready to bear the additional cost not only for improving road safety, but also for shortening the travel time,
- the unprotected road users mostly crossing dual carriageway roads were willing to pay the most for the opportunity to use a pedestrian tunnel or a footbridge and for reducing the number of fatalities,
- pedestrians and cyclists who use mainly crossings through a single carriageway road were most willing to pay for reducing the number of fatalities and seriously injured, as well as for the presence of traffic lights on single-stage pedestrian crossings,
- drivers who prefer driving in non-built-up areas did not pay attention to the length of the route or to the directly related travel time, and were willing to contribute to the costs of reducing the risk of being a fatality, a seriously injured or a slightly injured victim,
- the reduction in the number of fatalities was the most important for those surveyees who mostly travel in non-built-up areas by collision roads,
- the overall higher propensity to pay for risk reduction outside built-up areas may indicate a lower sense of safety in these areas – on interurban road.

Finally, despite significant improvements in safety, the risk of death on Polish roads is one of the highest in the European Union (Dyr *et al.,* 2017). By referring the obtained estimates to the VSL value in other countries, it can be concluded that the value of a statistical life in Poland belongs to one of the lowest, although the order of magnitude is comparable with the results in other countries.

The VSL value in the group of drivers in non-built-up area, which in terms of USD is USD 1.95 million, is less than the average value recorded amidst the 18 OECD countries in the year 2014, of ca. USD 2.8 million, but is greater than the value of VSL in countries such as Hungary and Malaysia (USD 0.92 million) and Mexico (USD 0.4 million). The level of VSL value in Poland is similar to Israel (USD 1.67 million) and Spain (USD 1.7 million) (OCDE, 2016).

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