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**ACCIDENTS WITH TRACTORS AND AGRICULTURAL MACHINERY
IN PUBLIC TRANSPORT OF REPUBLIC OF SERBIA WITHOUT PROVINCES**

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Abstract: Working processes in agriculture nowadays cannot be imagined without the use of modern agricultural mechanization, especially primary power unit, tractor. Along with the tractor unit development and the benefits induced by its application, according to the author's research, these machines are one of the main causes of accidents with different types of violations of the participants, and the tragic consequences. The great number of those accidents with tractors and other agricultural machinery take place on the roads of public importance of the Republic of Serbia **WITHOUT PROVINCES**.

This paper deals with the problems and consequences of accidents that occurred in public transportation, on different categories of roads, which appear tractors and agricultural machinery, in the Republic of Serbia without provinces.

Tractors and agricultural machinery has a high risk factor in causing accidents and injuries of various degrees of participants in public transport. Between years 1990-2009, in Republic of Serbia public transport, 72 agricultural machinery operators died and 157 operators were seriously injured, on annual average basis. The material damage is enormous. The most influential factor in causing accidents is a man-handler agricultural machinery, primarily tractor driver behaviour, that is reflected through his psycho-physical condition, observance of traffic rules and other road users and of course expertise.

Varied and dangerous accidents and injuries caused by public transport drivers of tractors and other agricultural machinery in the central part of the Republic of Serbia, remains a fact of life. It is obvious that there is the lack of basic and special additional professional training machine operators and tractor drivers, constant professional and technical courses for the safe and proper use of modern agricultural machinery. Additional safety factor is technical condition and safety of machines themselves.

Keywords: Republic of Serbia, Public transportation, Tractors and agriculture machinery, Machine operator, Accidents.

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1. INTRODUCTION

Tractor machine is the unit with primary role in agriculture and it has a very high risk factor causing accidents and injuries by common forms of participants in the use of public transport in Serbia, regardless of whether it is aggregate with implements or standalone unit.

According to [7-10] and police records of the Republic of Serbia [11], for different types of roads in the Republic of Serbia, public transport, tractor drivers cause most of the traffic accidents in different and dangerous consequences.

Tractors have an important role in agricultural and other works (construction, forestry, etc.) and transportation when they move across different types of substrates and public roads. In these circumstances tractors are potentially dangerous operating machines, especially if they are not managed by specific rules of safety, prevention, protection, and regulatory requirements.

Data [8] showed that the tractor accidents and injuries most commonly occur in the fall, when the amount of work in agriculture increased. Injuries are very diverse, heavy and affect body parts operator, with the appearance of a high degree of disability [12], [13], [15], and incidents are accompanied by great material damage due to the high cost of these machines. Unfortunately, the tragic consequences for operators and other road users are very often.

There were more than 500,000 different types of tractors [7] in the Republic of Serbia in 2005. The tendency of annual growth of these machines is 5,000 to 20,000 units due to increased amount of agricultural work. In addition to the above mentioned number of tractors, Serbia has over 250,000 motor cultivators, more than 420,000 two-axle tractors and nearly 30,000 combines [7]. Therefore, the approximate number of mobile agricultural machines, with their own engine and ability to participate in public transportation in the Republic of Serbia, exceeds the number of 1,000,000 pieces. With such a high number of mobile machinery there is a high risk of increasing the annual occurrence of unfortunate events in public transport or in the very processes of agricultural production.

Some studies [7], shows that the financial impact caused by the event has special significance due to the movement of machines and tractors on public roads, bearing in mind that some models whose purchase price goes up to 150,000 Euros (or more), have the ability to achieve transport speed of 80 km/h. Prices of other self-propelled agricultural machines can be more than 200,000 Euros.

According to many researchers [3], [5], [14-16], [20], tractor machine is considered one of the main causes of accidents. In today's world, great attention is paid to safety [4], as well as raising safety culture and technical education of machine operators that participate in public transport, through various training programs.

Ergonomics significantly contributes to increased safety. The tractor cab signalling systems are built [10] that use audio and visual signals to inform and warn the operator of a variety of potential hazards during the process and protect against possible injuries and other accidents with possible tragic consequences.

2. MATERIALS AND METHODS

In public transport of Republic of Serbia **WITHOUT PROVINCES**, in the period 1990-2009 were analyzed incidents that occurred during the transport activities of the tractor and the tractor with connected machine in public transport for different types of roads in the Republic of Serbia without provinces (Kosovo and Metohija and Vojvodina). Number of accidents with

tractors in public transport, was obtained [11] from the Ministry of Internal Affairs of the Republic of Serbia - Traffic police department.

The data presented in this paper were obtained by numerical and analytical methods, and statistical evaluation was performed by applying the analysis of time series. Data are presented in a form of the tables and graphs and analyzed by year and consequences of accidents for the period 1990-2009.

3. RESULTS

Tractors have significant application in agricultural operations and transport when move along the agricultural fields with different characteristics (land of various topographic characteristics, categorized roads, etc.) and on public roads.

In these situations, they are potentially dangerous machinery, especially in the case if they are not used to certain rules of safety, prevention and care. In the literature [1], [3], [4], [6], [10], [15] and [20], the tractor and its operator are considered responsible for many accidents in agriculture, forestry and the works in the construction industry. The most common causes were improper use (tractor driving inadequate technique the speed of traffic on inclines or side slopes, with the advent of rollover) and bad maintenance (repairs or various interventions in some parts, replacement tires, filling, coolant or equivalent) [9], [10], [13] and [16].

According to research data [8-10], in Republic of Serbia, in the period 1980-1988., over 900 tractor drivers (approximately 112 per year) were killed in various accidents and the locations (the movement of the tractor, down, or side-slope, improper towing tractor defective, others ride in a tractor in places that do not have a seat, driving speeding, rolling over, etc.). In direct accidents in public transport in Republic of Serbia (without provinces) from 1990 to 2000, the average number of tragically killed tractor drivers was 76 people.



Fig. 1. Accidents with tractors and their tragic consequences

The most common causes of accidents in agricultural production and public transport, [6], [8], [19], with involved tractors and other self-propelled agricultural machines are:

- Inattention of machine operators,
- Insufficient level of training for work,
- Non-compliance with traffic regulations,
- Lack of safety measures, and
- the use of technically obsolete or faulty machines.

Table 1. Consequences of road traffic accidents which are caused by tractor drivers from 1990 to 2009

Cons. Year	Minore Injuries	Heavy Injuries	Total Injured	Tragic Casualties	Total Casualties
1990	213	176	389	107	496
1991	198	175	373	94	467
1992	209	148	357	80	437
1993	169	153	322	69	391
1994	203	136	339	74	413
1995	176	127	303	66	369
1996	361	204	565	72	637
1997	343	248	591	106	697
1998	302	193	495	81	576
1999	278	143	421	55	476
2000	299	163	462	69	531
2001	279	166	445	77	522
2002	213	153	366	74	440
2003	258	150	408	65	473
2004	279	152	431	71	502
2005	283	129	412	58	470
2006	294	147	441	54	495
2007	242	119	361	64	425
2008	235	134	369	45	414
2009	272	133	405	57	462
Total	5106	3149	8255	1438	9693
%	61,8*	38,2*	85,2**	14,8**	100
Average per Year	255,3	157,4	412,7	71,9	484,6

* in relation with total injured

**in relation with total casualties

On the territory of the Republic of Serbia (without provinces), according to [8-10], in the last decade from 1990-2009, in direct accidents in public transport, often participate tractor operators (killed people). Information on number of casualties in road accidents (Table 1), which caused the tractor operators, for the period 1990-2009, indicates an especially difficult aspect of mishaps and accidents that cause the man and the tractor.

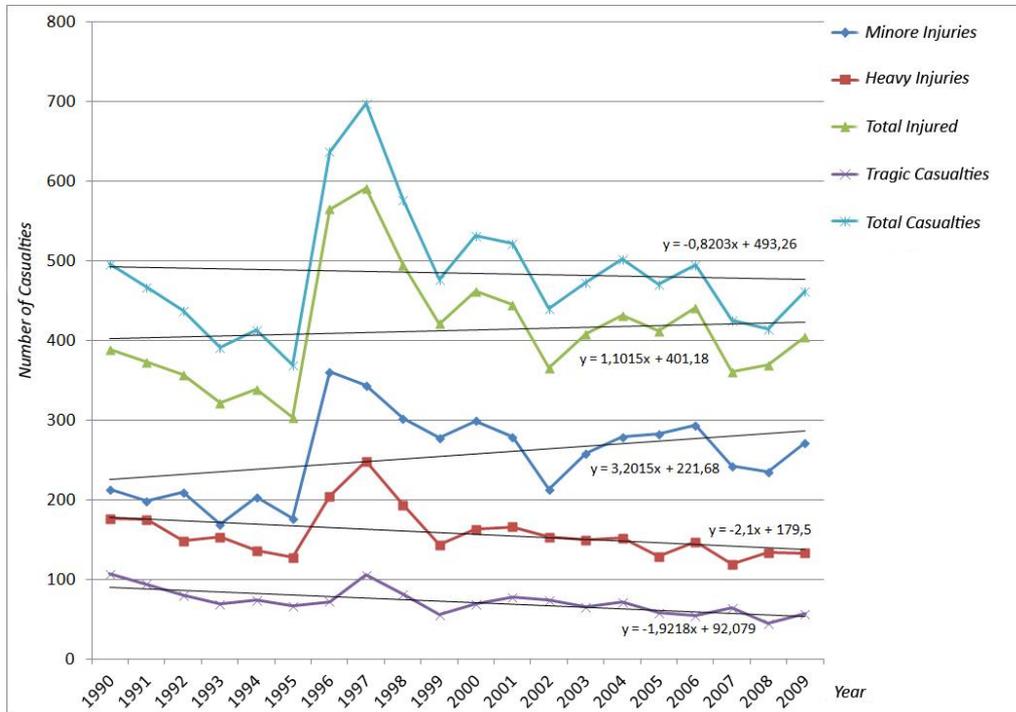


Fig. 2. The trend and graphic view of injuries and their types for the period 1999-2009

The public transport in the Republic of Serbia, excluding the provinces, the research period from 1990-2009., the total of 9693 persons were casualties in accidents that are caused by operators of tractors and other agricultural machinery, of which 14.8% or 1438 people tragically lost their lives, while more minored and heavy injured 8255 persons or 85.2%. Of the total number of injured, 61.8% or 5106 persons received minor injuries, while 38.2% or 3149 persons sustained heavy injuries that often result in permanent disability [12], [13] and [15].

Statistical analysis showed that during the research period, average per year 484.6 persons experienced accident, of which 71.9 persons tragically, and 412.7 people is injured (255,3 with minor injuries and 177,4 with heavy injuries).

The analysis of time series for different types of injuries (Figure 2) it can be concluded that the trend of the total number of casualties decrease ($y = -0,8203x + 493,26$), along with the trend of heavy injuries ($y = -2,1x + 179,5$) and the tragic trend in the number of casualties ($y = -1,9218x + 92,079$). In contrast to these indicators, the trend in the number of casualties with minor physical injuries($y = 3,2015x + 221,68$), as well as the trend of the total number of injured ($y = 1,1015x + 401,18$), tend to increase.



Fig. 3. Defective tractor units in the public transport of Serbia, [9], [22]

On the basis of the data presented, it can be concluded that there is a slightly decrease in the number of fatalities in accidents with tractors in the period 1990- 2009. The reason for reducing the number of people killed, in addition to the human factor is the influence factor of improving the technical characteristics of modern machinery and the tractors that are all over-represented in agriculture of Serbia (additional safety devices, cab signaling and alarm systems, etc.).

The work with tractors and other agricultural machines have tragic consequences, mostly because agricultural machinery operators do not work according to the rules and regulations that exist. The analysis of investigations [6], [14], [16], [17] and [21] as well as the results of our investigations in the Republic of Serbia (without provinces), it is evident that accidents with tractors and other agricultural machinery, mobile addition to the many preventive measures, legislation and continue to occur daily. It is primarily the result of: negligence, improper handling, machine faults (Figure 3), lack of education and lack of discipline (drinking alcohol during work), and the operator tiredness.

The accidents that occurs due lack of permanent vocational training and professional courses for the proper use and the maintenance of tractors and machines, that have to be organized and the coordinated and implemented seriously, including above all the institutions of society (Ministry of Agriculture, Ministry of Infrastructure and the Transport, the Ministry of the Interior, educational institutions, farmers, and the other relevant institutions and individuals).

4. CONCLUSIONS

Analyses show that traffic accidents and accidents with tractors and other agricultural machines in the Republic of Serbia (without provinces) and in public transport period 1990-2009, are characterized by:

- tragically killed tractor drivers or participants (deaths), there were approximately 72,
- severely injured participants (later of severe disability and the welfare cases [2], [12], [18]) 157,
- easily injured participants was 255,

- average annual number of casualties in accidents was the 484,
- the trend of the total number of casualties decrease ($y = -0,8203x + 493,26$), along with the trend of heavy injuries ($y = -2,1x + 179,5$) and the tragic trend in the number of casualties ($y = -1,9218x + 92,079$), and
- trend in the number of casualties with minor physical injuries ($y = 3,2015x + 221,68$), as well as the trend of the total number of injured ($y = 1,1015x + 401,18$), tend to increase.

Accidents and disasters in working with agricultural machines and tractors nowadays are very common in Republic of Serbia (without provinces), since there is no ongoing training, supporting vocational courses for the proper use and maintenance of these machines. There are significant gaps in the knowledge and application of traffic rules in the warp tractor drivers, as well as irresponsible and undisciplined in the use of tractors and other removable agricultural machinery.

The future research and the preventive action should be directed towards the final training operators and increasing technical education along with the security of tractors in adopting legislative measures on mandatory installation of cab or protective frames and seat belts on all tractors used in agriculture in the Republic of Serbia (without provinces).

Coming period requires a comprehensive commitment to reduce the number of incidents and accidents in the course of agricultural machinery and tractors. This primarily means that it is necessary to ensure continuous course of business in agricultural production, with the greatest respect for all prescribed policies and laws on safety of machines, and the in particular the Law on Road Traffic Safety, when these machines are found in the transport process on public traffic areas.

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