

# Importance of Tires: Case Study in Hungary

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**Abstract** Nowadays lots of effort have been done in EU-wide to enhance road safety. Huge effort has been done by vehicle manufacturers and road infrastructure managers. Very little is being known about vehicle owners and their role in road safety. Even less research has been done in season tire changing. In this paper author investigated the tire changing systems and their financial consequence. Firstly the accidental dataset were investigated secondly the financial consequence of season tire changing were analysed especially in Hungary. Findings in this study showed that tire related fatal road accidents become more and more significant in Hungary. Furthermore seasonally changed summer and winter tires are less expensive if proper usage is considered without overrunning. The harmful environmental effect of lower renewal interval of season tires are also mentioned.

**Keywords:** *season tire changing, financial consequence*

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## 1. Introduction

Health Organization has warned that traffic accidents are on a path to becoming the fifth leading cause of premature mortality worldwide by 2030 [1]. Road safety targets aim to reduce the likelihood of a crash and to reduce the severity of a crash [2,3]. Road safety concerns everybody who use road infrastructure [4,5]. Using the roads and streets is part of the every-day life, but each year almost 30 000 lives are lost on these roads in EU. In Hungary recently (2014), 626 died in road accidents. This is an unacceptably high price to pay. In addition, the road accidents cause real socio-economic costs of around 2% of EU GDP every year.

The responsibility of road accidents is shared, primarily between the vehicle manufacturers, the infrastructure managers, the local and national authorities and the vehicle owners. Huge effort has been made for the decrease of fatal road accidents. In the recent years huge amount of energy, time and money has been spent, a lot of measures (improve of active and passive safety systems, forgiving and self-explanatory roads, improvement of education and training system) have been done in order to reduce the number of fatal accidents. Mostly vehicle manufacturers [6,7,8] and infrastructure managers were involved. Little source of literature were found on tire changing habits and their financial analysis. Therefore main aim was the author to investigate the economic effect of tyre changing habits. Season related tyre changing has an unquestionable advantage on road safety.

Regard to the literature overview, several types of tire exists nowadays. Some drivers use all-season tires that are capable of securing the safety of driver and vehicle in all season (Figure 1):



Figure 1. Example of all season tire type tread

Some drivers use summer tire or winter tire (Figure 2a and Figure 2b):



Figure 2. Example of summer (2a) and winter (2b) tire type tread

Some even using studded tire on icy or snowy roads (Figure 3).

Author must highlight that there is a strong difference between winter tire and studded tire, this difference has a huge influence on vehicle dynamics.

The importance of tires for road safety has been studied over a long period of time. The effectiveness of studded versus non-studded tires became an issue already in the early seventies, showing large effects on the risk of crashes under icy or snowy road conditions. It has been proved a behavioural adaptation, a psychological change to the type of tire, in that drivers of cars with studded tires

drive faster than drivers of cars with other tires. The result of statistical analysis shows that studded tires were found to reduce the risk of a fatal loss-of-control crash without electronic stability control on ice or snow by 65%. No statistically significant results were found for crashes on dry or wet asphalt [9]. The use of studded tires is likely to influence the safety not just of the cars using such tires, but also the safety of cars not using studded tires. The reason for this is that the studs tear down snow or ice and thus clears the road surface more quickly of snow or ice than if studded tires were not used [10]. Studded tires are commonly used only in Nordic countries in Europe therefore this type of tire was excluded from further investigation.



Figure 3. Example of studded tire type tread

Nowadays it is started to draw attention on vehicle owners. In this paper the Hungarian situation was examined. Tire related accidents and financing construction was analysed, firstly the accidental dataset and secondly the financial consequence. There is no state regulation of which tire should be used or obligation of studded tyre on winter time.

Although in some European countries there is obligation of studded tire usage in winter time and their road administrators' support and manage expressways with the goal of improving the effectiveness and efficiency of a road safety and security aspects. However, nowadays in Hungary not all road vehicles are equipped with winter tires in winter time. Parallel with this in Japan the administrators will not visually inspect the suitability of the tires of each road vehicles considering the current state of the road surface but automates the tire controlling based on their vibration signal [11].

The hypothesis of the paper that correct tire usage could significantly improve road safety. It is important to mention about accidents the tires technical condition, therefore two different renewal interval were analysed.

## 2. Methodology

In this paper two different tire changing strategy were compared and analysed.

Firstly the all-season tires were analysed in case of passenger cars and trucks. Due their ageing it is necessary to change these tire not later than in the period of three

years in case of passenger cars and in the period of two years in case of trucks according to the Hungarian regulation.

Secondly, the season (summer and winter tires are separated) tires were analysed in case of passenger cars and trucks. Due their ageing it is necessary to change these tire not later than in the period of five years in case of passenger cars and in the period of three years in case of trucks according to the Hungarian regulation. Currently there is no governmental decision on which system can be used in Hungary. This paper aims to analyse both system (Table 1):

Table 1. Tire Changing Intervals

Tire Type	Passenger Car	Trucks
All 4 season	3	2
Summer/winter	5	3

Goodness of tires were investigated as considering transient regime as follows:

$$G = e^{-\frac{t}{T}} \quad (1)$$

where:

G: goodness of tyre [%]

t: specific parameter where aging and usage of tyre where also considered [years]

T: Tire changing interval [years] (Table 1).

For determining  $t$  parameter it was necessary to incorporate aging and usage of tires. Whereas all season tyres are aging and used simultaneously summer tires are used only in summer time but aging all year. Therefore behavioural matrix of tyres were conducted as follows. Let us describe  $\overline{AS}$ ,  $\overline{S}$  and  $\overline{W}$  matrixes, where  $\overline{AS}$  describe the behaviour of all season tires,  $\overline{S}$  describes summer tyre behaviour and  $\overline{W}$  matrix describe winter tyre behaviour. In order to incorporate the tyre changing interval the modulus function of changing interval was used.

$$G = e^{-\frac{\text{mod}(I_c)}{I_c BM}} \quad (2)$$

where:

$I_c$ : Interval of tire changing [years]

$\text{mod}(I_c)$ : is the elapsed years since last tyre renewal

BM: Behavioural matrix that containing the infos about aging and usage [-] as  $\overline{AS}$ ,  $\overline{S}$  and  $\overline{W}$  matrixes.

In Hungary the National Transport Authority is obligatory to check the condition of tires on technical investigation of the vehicle. Each and every year approximately 2 millions of vehicles go under technical inspections. In Hungary there are 1250 place for vehicle technical inspection in 2012. Accident dataset shows that tire problems become more significant (Table 2):

Table 2. Ratio of tire problems in accidents

	2007	2008	2009	2010	2011	2012
Puncture [pcs]	32	27	20	15	19	22
Puncture [%]	100%	84%	63%	47%	59%	69%
Fatal [pcs]	1232	996	822	740	563	541
Fatal[%]	100%	81%	67%	60%	46%	44%
Puncture/Fatal [%]	3%	3%	2%	2%	3%	4%

(source: Hungarian Statistical Office).

In the last recent years the relative role of tires are becoming more and more important in road safety. Awareness of drives and owners need to be increased.

Based on the changing intervals for every road vehicle category – passenger car and truck – estimation was done in order to the different tire changing strategies could be compared (Figure 4 and Figure 5):

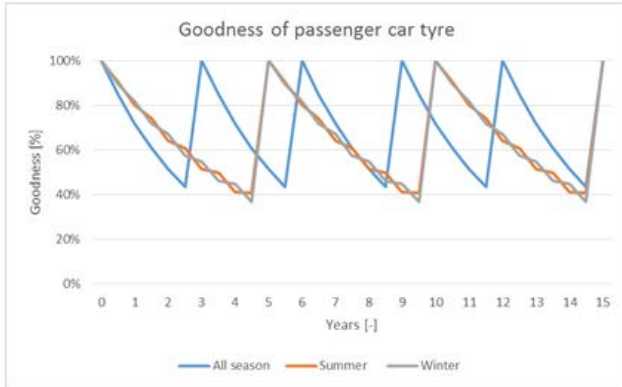


Figure 4. Analysis of different tyre usage strategies for passenger cars

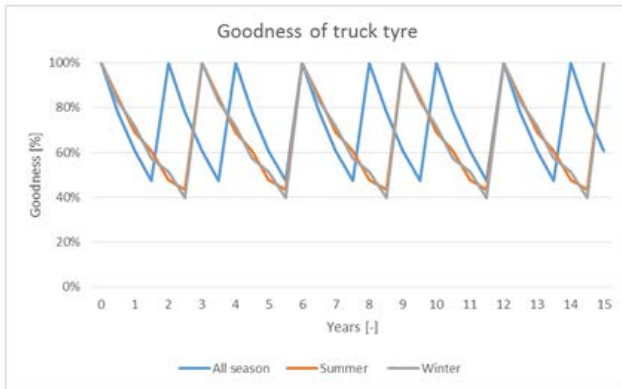


Figure 5. Analysis of different tyre usage strategies for passenger cars

For financial consequences the cost of tire and the changing cost were also summed up and considered on yearly basis for better comparison possibilities (1):

$$T_C = \frac{(C_t + C_c) \cdot N_t}{I_c} \quad (3)$$

$T_c$ : Total cost of each tyre strategy [HUF]

$C_t$ : Cost of tire [HUF]

$C_c$ : Cost of tire changing [HUF]

$N_t$ : Number of tires of vehicle category [-]

As different changing intervals were considered it was necessary to consider the costs on yearly base in order to be compared.

### 3. Results

According to the effects of tires on road safety, which shown in Figure 6. it can be clearly identified that puncture tires are playing an increasing role of accidents.

Although generally all-season tires are more expensive both for passenger cars and for trucks as well, their decreased tire changing interval caused more expense on yearly base.

In Hungary there are approximately 3 million passenger cars. For them using an all season tire and changing in every three years would cost 35 000 HUF, using separately winter and summer tire and changing them every summer and winter for five years would cost 25 000 HUF on yearly base.

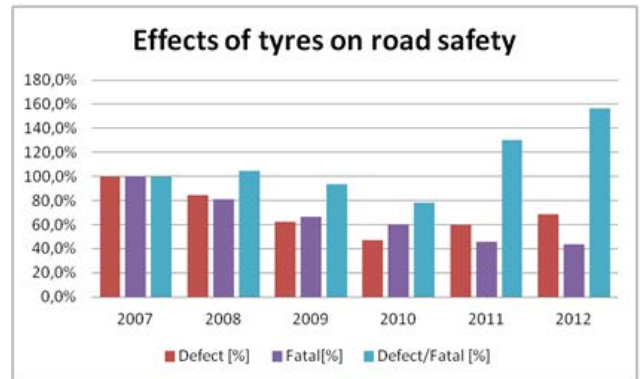


Figure 6. Changes of fatal accident, of defects caused fatal accidents, and their ratio from 2007-2012

(source: Hungarian Statistical Office)

\*please note that 2007 is 100 %

In Hungary there are approximately 420 thousand registered trucks. For them using a 4 seasoned tire and changing in every two years would cost 156 000 HUF, using separately winter and summer tire and changing them every summer and winter for three years would cost 142 000 HUF on yearly base (Figure 7):

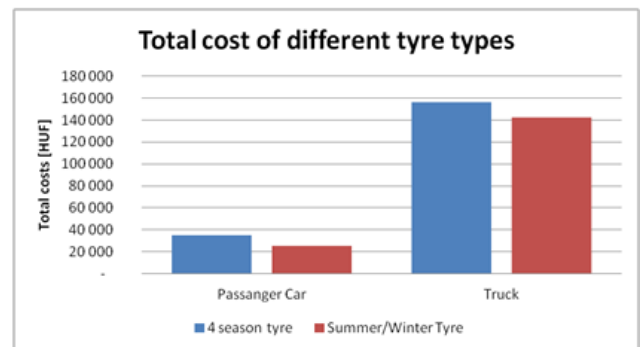


Figure 7. Total costs of different tyre types

\*please note costs converted on yearly base

As it can be seen considering season – separately winter and summer - tires not only having road safety advantages but also financial beneficiary. In case of passenger cars 28.6 % and in case of trucks 9 % difference of total costs could be observed.

### 4. Conclusion

About 1.4 billion tires for vehicles are manufactured annually all over the world while almost equal amount of tires are generated as waste in every year, while road transport tires should be changed within the cycle of 3-5 years [12]. In the 27 members European Union,  $3.2 \times 10^3$  metric tons of used tires were accumulated in 2010 [13]. Consequently the appropriate treatment and/or recycling of post-consumer and post-industrial polymeric wastes including scrap tires are one of the most pressing challenges in our environmental concerns. Collection and

disposal of used tires are strictly controlled by EU regulations and of course local regulations in advance [14]. Since different regulations exist in EU and in the Third World, a possible utilization of used tires could be their export to a country with gentle prescriptions on tire quality, so they could be forward their “life” as running tires, moreover their life cycle can be and according to the Hungarian experience is extended.

Based on the described methodology the stricter change of season (separated summer and winter tires) would cause  $0.2 \times 10^3$  metric tons of used tires only in Hungary!

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