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Road safety aspects in the management of road maintenance

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Abstract. The last decade in Poland has been a period of intense expansion of the public roads network. During this period a spectacular increase in the number of vehicles and traffic intensities has been noticed. Considering this, organising and carrying out maintenance work is increasingly important. The paper provides a brief analysis of currently used maintenance models in Europe and Poland and their characteristics which determine the safety of both road users and workers carrying out roadworks. The historical change in the approach towards the quality of road maintenance, the evolution of the economic model and a description of how the expectations and preferences of drivers have changed are included in the paper. In addition, the paper presents specific road maintenance standards and suggestions for maintenance and road works. The summary of the paper gives a recommendation for future development directions and suggests which features of road maintenance models and standards improve safety to the highest degree, particularly in the context of the further development of the road network.

1 Introduction

The last decade has been a period of intense expansion of the public roads network in Poland. After years of delays with archaic roads that did not meet the real needs of network traffic, road construction is finally taking shape. Although this process is still ongoing, we are starting a new investment programme based on European funds. It will produce unprecedented results in the history of Polish roads. It will lead to the creation of the country's highest functional level of roads, highways and expressways. It should be assumed that these roads will carry most of the supra-regional traffic. The traffic will move with particular characteristics and specific features such as speed, travel time or behaviour of road users also in terms of their expectations of the applicable standards of living.

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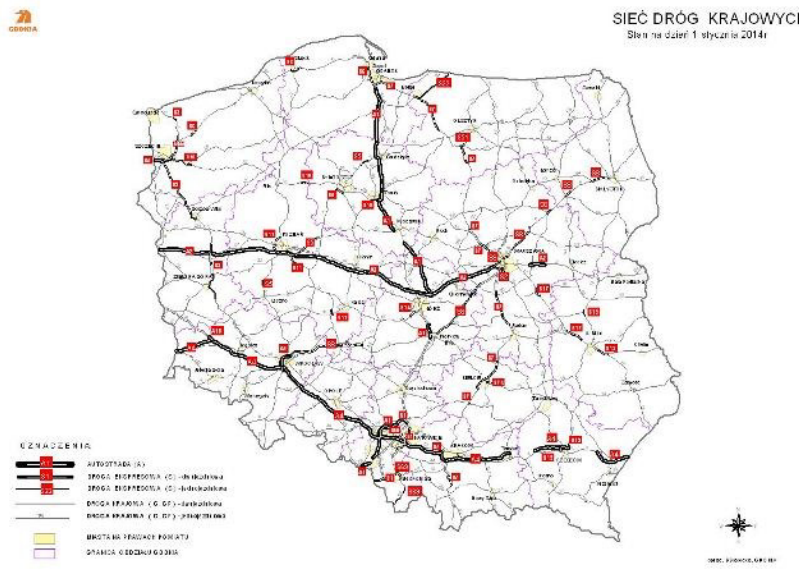

Fig. 1. The network of national roads in Poland in 2014. Source: General Directorate for National Roads and Motorways in Poland

Fig. 2. The network of national roads in Poland in 2025. Source: General Directorate for National Roads and Motorways in Poland.

2 Problems of road safety in the traditional approach to road maintenance.

So far in the course of the company's operations and road safety research, particularly in the area of causes of road incidents, the problem of the quality and implementation of maintenance has never given safety a priority. It is a commonly known paradoxical claim which is that the worse the maintenance of the road is (worse quality of the roads, especially surface), the lower the risk of road accidents. This relation can be found on EuroRAP's risk

maps. Of course, the paradox of this relationship is that the roads cannot be used as normal because they are in a such bad shape which forces drivers to reduce speed radically. Obviously, this cannot be treated as normal. The starting point for the analysis must be a road in good or satisfactory condition in terms of quality assessment nomenclature. It must be a road that allows drivers to drive at the speed limit safely. Only then do we realise that apart from the standard reasons for accidents caused by driver behaviour or the condition of the vehicle, there are other important reasons such as road maintenance and quality of maintenance works. Roads of the highest class, with maximum speed limits and top quality of the road must deliver high standards of maintenance to ensure safety.

The basic road safety problems for road maintenance in the traditional approach are:

- lack of homogenous standards for marking vehicles carrying out maintenance work,
- lack of homogenous standards for marking works areas,
- lack of minimum quality standards, poor maintenance of infrastructure,
- maintenance standards are not delivered, for example time of day, season, max. length of the difficulties, chaotic and uncoordinated outsourcing of maintenance with no relation to the real needs,
- lack of operating standards in an emergency situation on the road,
- lack of cooperation standards with emergency services,
- lack of assessment indicators to meet the standards, especially in terms of quality,
- lack of uniform rules to control and determine the consequences of failure to meet the standard.

Maintenance work carried out by different managers (sometimes even within a single organization) often differs not only in the scope or frequency, but also the form, method of delivery and method of securing the work zone. These inconsistencies can adversely affect safety [1].

3 The experience of European countries

The aspect of road safety in the implementation of maintenance works is present in the practice of all road managers in Europe. No matter which model of maintenance has been accepted, countries have developed their characteristic approach to the problem.

Table 1. The maintenance management system in England [2].

The Board of Roads	The Highways Agency
Model of maintenance	Comprehensive, in PBC system
Standards	Defined, catalogued (BVPI catalogue), taking into account the expectations of road users (Citizens Charter)
The quality of maintenance	At the level of expectations

Table 2. The maintenance management system in Germany [2].

The Board of Roads	
Model of maintenance	Traditional, implemented by the federal states, the Länder
Standards	At the internal level, enforced on the basis of indicators
The quality of maintenance	High

Table 3. The maintenance management system in Austria [2].

The Board of Roads	ASFINAG (commercial company)
Model of maintenance	Professional, comprehensive
Standards	Defined also in the busy belts including maximum delay of the timing of traffic,
The quality of maintenance	High

4 Historical changes in maintenance model, taking into account aspects of road safety.

In Poland, the transformation of the management model of road maintenance and the evolution of the approach to road safety went hand in hand with general changes in the socio-economic transformation of the political system in 1989. In a free market economy the economic effectiveness of the approaches has changed considerably. Effectiveness of the works in reducing road incidents also came to the fore. The importance of these problems was increasing in subsequent years in proportion to the development of the road network and road traffic.

The unquestionable leader of these changes was from the beginning, and still is the largest manager of public roads in Poland, which is the General Directorate for National Roads and Motorways. The General Directorate for National Roads and Motorways is thought to be the unquestionable leader of these changes. The company manages the whole country network of more than 19 000 km of national roads of different classes and different characteristics. This network, since the establishment of GDDKiA until now, has been managed on the basis of the evolving model of maintenance, using the strength of their own forces and resources, through models of commissioning work at different levels of aggregation, finally ordering a comprehensive maintenance model called “Keep Up the Standard”. The process proceeded in a planned and systematic way.

Maintenance management model has evolved in the following stages [3]:
- Stage 0, 1989 - 1999 - partly traditional model / partly commissioned works,
- Stage I, 1999 - 2004 - commissioned distributed works model,
- Stage II, 2004 - 2011 - commissioned cumulative works model,
- Stage III, 2011 - 2015 - “quasi standard” model,
- Stage IV, from 2016 - “Keep Up the Standard” model.

4.1 Stage 0 (1989 – 1999) – partly traditional model

The model implemented in the period before the GDDKiA was established within the framework of its legal predecessors, took place in the period of political transformation i.e. from 1989. Maintenance was carried out by in-house employees with some commissioning of more specialized jobs. The road manager had their own employees and some equipment, trucks and vans. Materials for repairs and maintenance (signs, posts, concrete elements, materials for minor repairs, etc.) were bought by the road manager.

Features of the model:
- GDDKiA road workers: in-house/full-time employment,
- equipment: own,
- materials: own
- outsourcing: only for specialized works,
- lack of uniform standards of road safety,

- lack of a system to control the performance of your own work (ad hoc audit)
- lack of indicators to assess the effectiveness of road safety solutions.

4.2 Stage I (1999 – 2004) - commissioned distributed works model

When the administrative changes in the country and the creation of GDDKiA took place, the manager continued efforts to merge the different types of outsourced works, which mostly led to a passive human resources policy at the level of workers and to minimizing the number of their existing equipment. Outsourced maintenance work began in larger packages along with the determination of the manner of implementation.

Features of the model:
- GDDKiA workers: minimum number,
- GDDKiA equipment: minimum level,
- outsourcing: outsourced by types of works with defined methods of implementation,
- lack of uniform road safety standards,
- control system implemented by GDDKiA employees towards third parties performed only by checking compliance with the contract,
- lack of indicators to assess the effectiveness of road safety solutions.

4.3 Stage II (2004 – 2011) - commissioned cumulative works model

From 2004 GDDKiA in its new orders introduced specific scopes depending on the groups of works to which they belonged. In particular, works were aggregated into groups: winter maintenance, routine maintenance of roads, bridges routine maintenance. The agreement assumed specific scopes of road maintenance, repetitive work was valued individually, separately for each item.

Features of the model:
- GDDKiA workers: none
- equipment: none
- materials: property of the contractor
- outsourcing: outsourced by assortments with defined methods of implementation,
- lack of uniform road safety standards,
- control system implemented by GDDKiA employees towards third parties performed only by checking compliance with the contract,
- lack of indicators to assess the effectiveness of road safety solutions.

4.4 Stage III (2011 – 2015) - “quasi standard” model

The model of commissioned works was to include quality indicators. Prior to that in 2015, the Gdansk branch of GDDKiA introduced an intermediate model. It was agreed that previous framework contracts would bring together all the specific works with the traditional division of current road maintenance, winter road maintenance and current bridge maintenance. One contractor did all the work in the entire region. Fixed work schedules were introduced with first standards for work and quality of maintenance. The contractor was informed about the requirements regarding staff, equipment and facilities. Works became standardised. All regulations were fully harmonized across the road network irrespective of the Region. For the whole road network the Department “Order Description” made sure that the same principles of carrying out work were followed. The only difference was in sections of roads and the scope of work. Uniformed rules for commissioning, inspection and acceptance were also introduced, among others the so-called “matrix of control” was introduced.

Features of the model:
- GDDKiA workers: none
- equipment: none
- materials: none
- outsourcing: clustered in groups of 3 assortments,
- the first uniform standards for the whole region were introduced,
- control system implemented by GDDKiA employees towards third parties performed only by checking compliance with the contract,
- lack of indicators to assess the effectiveness of road safety solutions.

4.5 Stage IV (from 2010 to 2016) - "Keep Up the Standard" model.

In parallel, from 2010, work began on developing the principles of quality indicator-based contracts. Initially the system was used on selected sections of expressways but has been extended to cover more than one road section. A pilot model "Keep Up the Standard" was introduced and from 1 January 2016 the road maintenance system now covers the entire network of national roads across the region. The first solution was applied by GDDKiA Branch in Gdansk.

Features of the model:
- GDDKiA workers: minimum number,
- GDDKiA equipment: minimum level,
- outsourcing: one contract including all the maintenance work, using a flat-rate system contracted by assortments with defined methods of implementation,
- uniform standards for road safety including:
  - standards for marking equipment and personnel,
  - standards for conducting ongoing monitoring of road safety (road safety patrols)
  - standards for work signage,
  - standards of safe work,
  - standard methods for carrying out the work, the time of day, day of week
  - standards for achieving readiness,
  - standards of cooperation with emergency services,
  - standards of the technical condition of road elements that may have an impact on road safety,
- indicator system for evaluating the effectiveness of road safety solutions,
- professional system of control of standards carried out by employees of GDDKiA to check external companies,
- model with features similar to systems used in the countries of Western Europe.

Table 4 Maintenance management system "Keep the Standard" in Poland.

The Board of Roads	GDDKiA
Model of maintenance	Complex "Keep Up the Standard"
Standards	Specific, consistent for the whole network
The quality of maintenance	High, at the level of expectations

5 Conclusions and recommendations.

The dynamic development of the road network, expansion of the road system of the highest category dedicated to high speeds and increased traffic flows, as well as the expectations of

the drivers themselves mean that targeted solutions for infrastructure management will be required with road safety as a priority. Such models already exist in other European countries, and although they differ from each other in the details they have much in common. It is clear that they take into account the impact of the quality of maintenance and delivery of maintenance works to reduce the risk of road accidents. While there are many different approaches to the same model of road infrastructure management, the recommended activities will be designed to improve road safety. They are:

- improving the efficiency of operations and, consequently, the quality of road maintenance,
- the introduction of standardized ways of implementing maintenance works,
- using tools and processes to support maintenance, such as: professional road information systems, ITS systems, emergency procedures.

There is no doubt that among the currently used models of maintenance, these objectives will be achieved fairly easily by using a system of indicators such as the model of area maintenance or "Keep Up the Standard" system. It is important to note, however, that the final shape of the model both in terms of quality standards and methods of road works should be preceded by research to be conducted along with the development of infrastructure, taking into account the experience of other countries and respect for regional conditions.

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