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Implementation of *Weigh-in-Motion* system in freight traffic management in urban areas

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Abstract

The article presents how the Weigh-in-Motion system can be used for managing Gdynia's freight traffic. Potential sites for weight pre-selection were identified in an analysis of the technical and location conditions. Situated directly in the east part of the Port of Gdynia a site was selected for a pilot implementation. Theoretical scenarios were simulated using an extended WIM system as a tool for controlling access to selected parts of the city. The results suggest that emissions can be reduced and traffic flows can be improved. The scenarios, however, are very general in character and should only be seen as an introduction into further and more detailed analyses to give a fuller understanding of the problem and the objectives of urban transport policy. In the Authors' opinion this work must be complemented with a verification of how the WIM can be introduced in Gdynia in formal and organisational terms. This should build on the experience from the CIVITAS "Dyn@mo" project. A number of statutory changes are required to allow local authorities to make a full use of the potential of WIM systems.

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Keywords: Weigh in Motion; traffic management; urban freight; traffic modelling; transport policy

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1. Introduction

Road traffic management in urban areas must rely on solutions that reflect the complexity of the problem. This includes the different needs of transport system users, demand for infrastructure and the relevant inter-relations. The latter may lead to a number of undesired phenomena. In the case of freight transport, the possible impacts may be the result of overloaded vehicles. This is particularly acute in the case of heavy goods vehicles operating on long hauls.

The problem of overloaded vehicles affects road traffic and urban transport policy in a number of ways. It leads to extensive wear and tear on roadways and puts other road users at risk. In functional terms, it also affects a city's policy on allowing heavy goods vehicles to specific parts of town. In an effort to reduce the number of overloaded vehicles and control access, a system can be used using the *Weigh in Motion* technology.

Considering the factors above, the article looks at how Gdynia could use the *Weigh in Motion* (*WIM*) system as an element of its transport policy designed to rationalise freight transport. The results that follow were produced in CIVITAS "Dyn@mo", a project in which Gdynia is the leader of a national consortium of partners.

The first part of the article presents a functional outline of WIM systems and the main reasons why they make sense. It also gives an outline of a single European standard which includes organisational recommendations. This is mentioned because of some formal requirements that were decisive for Gdynia's pilot implementation of the WIM system. Next, an overview of the procedure is given for selecting the pilot WIM location close to the Port of Gdynia. In part three of the article a model analysis is made of how the extended WIM system could be used as a tool of urban transport policy for controlling heavy goods vehicle access to selected areas of the city. This is the first time this analysis was conducted for Gdynia's freight transport system. Cities do not have effective tools for analysing and verifying such solutions (Kaszubowski, 2014). This is why efforts should be taken to develop effective methods to aid decision-making in the area of urban freight transport. The analysis is based on a comparison of theoretical control scenarios and how they affect traffic parameters and emissions (e.g.: CO_2). It is designed as a point of departure for detailed analyses using the tools developed in "Dyn@mo", i.e. a three-level transport model that has been extended with freight transport supply and demand data. The article ends with an analysis of formal and organisational conditions that determine the effectiveness of WIM on urban streets and a set of conclusions.

2. Overview of Weigh-in-Motion systems

2.1. Application areas of automatic weighing systems in transport

Weigh-in-motion systems (WIM) are designed for unobtrusive and continuous collection and monitoring of vehicle weight information. The range of collected data may vary from precise individual weight measurements for each heavy vehicle to aggregate vehicle weight profiles for selected road sections. WIM applications range from data collection for the determination and scheduling of maintenance activities to weight-related toll-fare pricing strategies and overweight vehicle detection possibly diverting the traffic to alternate routes (Yannis and Antoniou, 2005).

One of the most important drivers for WIM systems application is reduction of road surface deterioration caused by overloaded vehicles, especially when the control system is insufficient. Recent analysis has shown, that an increase of percentage overloaded vehicles from 0% to 20% can reduce the fatigue life of asphalt pavement up to 50% (Rys et al., 2015). Higher level of enforcement towards overloaded vehicles may however result in shifting of the freight that was being moved on overloaded vehicles onto vehicles compliant with regulations (Stephens et al. 2003). But it can be assumed that much less pavement damage is incurred in this situation, because the damaging effect of axle increase with relative increase of its load to the power of four.

Another domain where Weigh-in-Motion systems prove their effectiveness is improving truck safety. Overloaded trucks pose serious threats to road transportation operations with increased risks for road users, deterioration of road safety and on fair competition between transport modes and operators (Jacob and Feypell-de La Beaumelle, 2010). Of course, there are also severe impacts on the durability of infrastructure, i.e.: pavements and bridges, which influence road safety in general. When the current load exceeds the maximum permitted limit of a truck, several adverse consequences may occur: