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Urban traffic Incident Management in a digital society
An actor–network approach in information technology use in urban Europe

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ABSTRACT

In the last two decades, traffic Incident Management (IM) has become an advanced new tool to reduce and prevent congestion on the road network, especially in urban areas. IM involves the coordinated interactions of many public and private actors. To support these tasks in an effective way, advanced information systems are becoming increasingly important. This paper offers a broad overview of the principles and practices of IM, with particular reference to the Dutch situation. It aims to provide an empirical analysis of the critical success conditions for effective IM in the Netherlands based on an Internet survey questionnaire administered to stakeholders.

1. Introduction

Only a few centuries ago, 20% of the worlds' population lived in cities. With more than half of the population living in urban areas since 2007, society is now undergoing a gradual transition towards what has been called the 'urban century'. This transition is continuing with urbanization rates exceeding 70% in various European countries [1]. This mega-trend in population movement towards the city is the result of an exponential growth in world population and a rural–urban drift [2]. According to a European report [3], the urbanization rate may have risen to about 80% in the EU. The phenomenon of the 'urban century' raises many research and policy concerns.

Clearly, policy makers have made many efforts in the last 20 years to design policies which promote the use of Information and Communication Technologies (ICT) in order to realize sustainable urban development. The digital revolution has enabled cities and policy makers to realize the link between ICT and urban development. As a result, various forms of city concepts have been developed including: *wired cities* [4]; *technocities* [5]; *creative cities* [6]; *knowledge-based cities* [7]; *real-time city* [8]; *WIKI cities* [9,10]; networked cities [11]; *digital cities* [12]; *Live city* [13], and one of the latest concepts is the *smart city*. Wired cities focus on the existence of different infrastructures. Digital cities allow telecom applications to improve city living, while in technocities the emphasis is on city developments in cooperation with large technological projects. Creative and knowledge-based cities highlight creativity and knowledge flows. WIKI city, Live city, and real-time city integrate the use of sensor networks for monitoring and city management functions. Networked cities are seen as geographical hubs (virtual and real) in a modern networked space-economy with a global orientation. The smart city concept can be identified as an overall umbrella term which also focusses on smart mobility.

Smart cities can be defined as "territories with a high capacity for learning and innovation, which results from the creativity of their population, their institutions of knowledge creation, and their digital infrastructure for communication and knowledge management" [14]. The term 'smart city' is

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often used interchangeably with *intelligent*, *wired*, or *digital* city. Hollands [15] provides a comprehensive review on the smart city concept. The role of ICT is the main smart city subject discussed in the literature. Smart cities are mostly concerned with the design and applications of ICT – both as digital infrastructure and ICT usage – at the level of cities and regions [16]. Digital technologies have changed our ways of living and working. For example, the relationship between physical travel and telecommunications has been studied extensively in the literature in order to understand the direction in which the use of telecommunications influences mobility behavior [17]. Mokhtarian [18] has identified four possible relationships between physical travel and telecommunications: *Substitution*, *complementarity*, *modification*, and *neutrality*.

There is a great potential for digital technologies which should be exploited for the better management of complex urban systems. These systems are marked by connectivity and accessibility, and need to be governed from a systematic perspective in which ICT may play a major role. An important problem in densely-populated urban agglomerations is the vulnerability of the road network caused by traffic accidents. This paper aims to map out critical success factors of Incident Management (IM) which is based on advanced digital technologies. The paper presents the results from an empirical application of IM in the urbanized part of the Netherlands. It starts with a broad overview of IM, with particular emphasis on the Dutch situation. It then highlights the regulatory framework involved with effective traffic IM. The critical success factors are derived by using an Internet survey questionnaire administered to the relevant stakeholders. The overall aim of this paper is to address the role of traffic IM, with the goal to reduce and prevent congestion on the road network, especially in urban areas. Section 2 describes the challenges to reduce the inefficiencies of present-day urban systems. In Section 3, we first look at developments in the Netherlands in terms of regulation, policy, mobility, and safety issues. Section 4 focusses in more detail on the public and private actors involved, and the emergence of the information chain based on an actor–network approach. In Section 5, we analyze the increasingly important role of information, and the introduction of new information concepts to support traffic IM. Finally, in Section 6 we present our main findings from the Internet survey.

2. Traffic Incident Management

Europe has a relatively high population density, and consequently also a dense transportation network, especially in and around urban agglomerations in Western Europe. This region is one of the most urbanized areas in the world. High density networks may become vulnerable in peak hours. This prompts the question whether information technology can be instrumental in guaranteeing these networks a smooth through flow in urban areas. Road networks are part of a country's transport infrastructure, and are therefore subject to general transport policies. Traffic incidents have a significant impact on the normal operation of road networks. This impact has a vast effect on all road users and the surrounding community. Casualties need to be recovered quickly from the scene of an incident, and secondary incidents need to be avoided. Traffic delays due to incidents result in loss of time, disruptions to public transport schedules, financial loss to freight operators and businesses, and increased vehicle emissions due to traffic idling for extended periods of time.

An 'incident' is generally defined as "*an unforeseen (unpredictable) event that impacts on the safety and the capacity of the road network and that causes extra delay to road users*" [19]. The term 'incident' is defined in the Dutch regulatory framework as "*all the events (such as accidents, dropped cargo, stranded vehicles, collisions with incidents involving hazardous materials), which affect (or may affect) the capacity of the road and hinder the smooth flow of traffic with the exception of broken down vehicles on the hard shoulder, where there is a minimal and acceptable risk regarding the traffic flow and safety of the other traffic*" [20] (for a more detailed description, see Section 3.4). Each EU Member State has its own strategy and definitions for handling traffic incidents [19–23]. Central to all these definitions are the planned and coordinated measures for safe and quick restoration to normality. IM is, in general, the policy that, through a set of measures, aims to reduce both the negative effects on the traffic flow conditions and the effects on safety by shortening the period needed to clear the road after an incident has happened. It can also be seen as a process to detect, respond, and remove traffic incidents, and to restore traffic capacity.

The handling of an incident can be described on the basis of the activities necessary to reduce the damage caused by an incident. This serves to show where problems arise in the clearing of incidents, and is useful for determining what measures are needed [24,25]. In the literature there is no general agreement on the different phases of IM [see Table 1: 22,26–30]. In our analysis, we use Zwaneveld et al.'s [31] simplified version of IM phases, which comprises four phases: alerting; response and arrival; action; and normalization [30]. In some examples, the detection and warning phase are combined. In the literature, sometimes the normalization and flow recovery time are also combined into one phase. The verification phase is also an important process. However, in many examples, this phase is not included. An attempt to create a shared European agreement on the process phases can be found in CEDR [23].

Strategies to prevent incidents are, of course, preferable to strategies designed to respond to incidents. In many cases, human or technical failure plays an important role [32]. The main causes of road deaths are speeding, driving under the influence of alcohol or drugs, and not using seat belts.[4] Governments need to ensure that comprehensive laws cover the main risk factors [33,34].

Traffic IM can be seen as a special case of (simplified) crisis or disaster management in terms of organization and work processes. Disaster management involves a cycle which should consist of an organized effort to mitigate against, prepare for, respond to, and recover from a disaster [35]. Informed decisions are a prerequisite for the formulation of successful mitigation, response, preparedness, and recovery

[4] http://ec.europa.eu/transport/road_safety/topics/behaviour/index_en.htm

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