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The launching phase analysis of the implementation of polish largest intelligent transportation system

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ABSTRACT
The implementation of ITS is carried out with the use of standard project management tools. Therefore, it includes certain phases. One of the most difficult and risky phase of ITS implementation is launching of such projects. An important factor causing this difficulty is the fact that launching is being done on „living organism". Thus it has to be time-consuming mostly due to the necessity of a proper real-time city traffic data collection. Additional factors are occurring failures (eg. the tram network or traffic lights system) or accidents. Another problem are social expectations, which does not take into account the specifics of ITS implementation. The citizens expect immediate results. The aim of people responsible for the launching phase of such systems is to ensure smooth operation of all its components and to provide local community with information on a relatively long system activation to its full operation. This article presents the analysis of the launching phase of the biggest ITS in Poland.

KEYWORDS: intelligent transportation systems, implementation processes, advanced technologies

1. Introduction

ITS systems presence in cities has become more and more visible. Their numerous benefits [6] assure that they, will certainly operate in each city, bringing more and more opportunities in the future. They are an essential component of the concept of Smart City building [3]. Following their current direction of development, level of integration between various systems of this class will increase. Smart Transportation System [7] is considered as the next stage of development of ITS.

The expected increase in the use of ITS class systems requires right choices of appropriate ones from the offer available on the market and then, their implementation. These are very important steps and their correct conduction determines smooth operation of the chosen system after its start.

ITS systems are classified as advanced technologies [9]. Their implementation is a typical example of project and requires the appliance of methods and tools dedicated to project management and used by project managers [5]. In the course of their successful completion, often there are numerous problems [11] that need to be skillfully solved.

Problems revealed at the starting stage of such systems often have their roots in earlier phases of the project implementation and deployment of ITS and in the formal - legal barriers [4]. One must also take care of appropriate social interaction during the planning of the transportation system, which will include the ITS system [10].

Not all problems that arise in the implementation of ITS systems are predictable and preventable. Some are related to malfunctions and traffic accidents. In such cases, a project team should be organized in a way to react quickly. After their launching, such systems are able to identify accidents [12] and try to prevent them [1].

2. Characteristics of Lodz ITS System

At the end of 2015, ITS system in Lodz was launched. It is the largest system of this kind in Poland. It connects:

- 236 intersections, with induction loops mounted on them and 50 meters ahead,
- similar induction loops on pedestrian crossings and bicycle paths,
- 179 new cameras and additional 29 existing ones,
- various detector types (described below).

The system is designed to provide priority for public transport. Overall travel time through the city should be reduced, followed by the increase in safety and comfort level.

Numerous detectors have been installed, among them: cyclists (microwave detectors), pedestrians (the sensor keys), vehicles (inductive detectors) and video detectors. Moreover, switches and sensor traction was installed, wherever it was possible. In the first months of system operation, these systems have been tuned, for example: cyclist speed on microwave detector, so pedestrians are not identified as cyclists, or cars and motorcycles intruding on the cyclists area.

System measures the travel time of both, the „test vehicle" (made during the testing phase) and cars, trams or buses, depending on the measure implemented for public or private transport. Special information boards display information about the passage time of the measured sector. The measurement is carried on the basis of travel time on the entire length, number of stops and their causes. At the starting point of the measurement a counting meter starts to run. The watch stops at the ending point. For public transport, watch starts at the first vehicle stop, while the last stop on the line marks the ending point of measurement. For this purpose, 4 transport corridors were designed, one in north-south and one in east-west directions, and the other two on the right and left edge of the city.

Around Lodz there have been five times more cameras installed, than existed in the city before the ITS launching. There are a few its different configurations, such as high-speed CCTV cameras installed at major intersections in the amount of 50 pieces designed for monitoring purposes, or ANPR cameras for video measurement of travel time. Lodz system also includes 29 already existing cameras. Cameras' network is connected via IP protocol by optical fiber or copper cables. In total, in February 2016 the system includes 200 cameras. Yet, this quantity is still insufficient. With each investment project in the reconstruction of traffic lights the number of cameras will gradually increase.

Fig. 1. The map of transport corridors with operating measurement system of ITS in Lodz [13]

Fig. 2. The map of intersections connected to the system: existing and planned – in total number of 234 [13]

In Lodz, there are two variants of travel speed measurement: car and tram:

a. average car travel time

$$t = \frac{t_1 + t_2}{2}$$

where:

t_{pS1} - average travel time value on corridor S1

t_{pS2}- average travel time value on corridor S2
x = 1 for measurements „before", 2 for measurements „after"

b. average tram travel time

$$t_{ptx} = \frac{t_{pT1} + t_{pT2}}{2}$$

where:
t_{pT1} - average travel time value on corridor T1
t_{pT2} - average travel time value on corridor T2
X = 1 for measurements „before", 2 for measurements „after"

Outcome improvement is measured by monitoring the of efficiency indicator of Lodz ITS system. Assuming that Wps and Wpt indicators are not less than 5%, following formulas were adapted,

a. average car travel time improvement

$$W_{ps} = \left(1 - \frac{t_{ps2}}{t_{ps1}}\right) * 100\%$$

where:
t_{ps1} – average car travel time value „before"
t_{ps2} – average car travel time value „after"

b. average tram travel time improvement

$$Wpt = \left(1 - \frac{t_{pt2}}{t_{pt1}}\right) * 100\%$$

where:
t_{pt1} - average tram travel time value „before"
t_{pt2} - average tram travel time value „after"

Signs and variable message boards were mounted, allowing the system to inform drivers about the current road situation. They are situated at the key city entry routes.

3. Main stages of system implementation

First attempt to create ITS system in Lodz have been made during the construction of Lodz Regional Tram. This project meant to connect the city of Lodz, with its 711 thousand citizens, with its nearest satellites cities: Zgierz at the north with the population of 57 thousand people and Pabianice at the south with 67 thousand people [2]. The construction started in July 2007 and the first phase - Lodz part – was opened on the 1st July 2008 [22]. The parts of project in Zgierz and Pabianice have never been completed. All tram stops in Lodz were modified and equipped with passenger information system. Electronic display devices were installed at each of 37 stops. Displays inform the passengers about nearest departure times, with direction and line number. Additionally traffic control system ensures that the public communication has the priority.

Fig. 3. Lodz Regional Tram stop display device [22]

Another step was the construction of main West – East artery of Lodz, nicknamed "Trasa W-Z" (which simply means E–W route in Polish). As part of this investment, Lodz commissioned the construction of the new, extensive ITS system. The assumption for the system was to connect 236 [14] major intersections within the city into one network managed by operators from the headquarters for this system. Investment contract have been signed in March 2013 by Hanna Zdanowska - the President of the city of Lodz, Grzegorz Nita – the Director of ZDiT (Polish: "Zarząd Dróg i Transportu", The Board of Roads and Transport) and contractor representatives [8]. In November 2013 the schedule for central section was provided. [15] Central section was the biggest, most extensive part of construction, with its central public communication interchange stop – connecting Lodz Regional Tram and W - Z route, and with a new tunnel project. All phases of these sections were planned to be opened in September 2015.

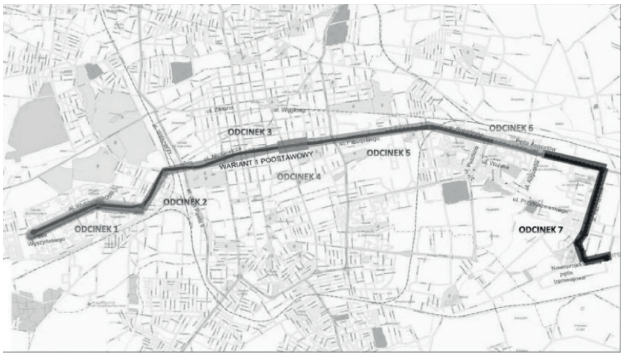

Fig. 4. E-W route in the city of Lodz [13]

In this period of time most of the ITS system construction works have been conducted. Existing Lodz Regional Tram system was adapted and connected with the new ITS system. Over 100 intersections were modernized, including new street lights and cameras network. 50 kilometers of optical fiber connected 236 [14] intersections into one system. Works were organized in such a way, that the difficulties felt by city drivers were minimal. All intersections connected to the system were equipped with induction loops, designed for vehicle detection on all lanes. Similar loops were constructed for tram lines, bus lanes and stops. According to the Board of Roads and Transport representative, they are situated at the stop line and 30 to 50 meters ahead. Induction loops are not a new technology in Lodz. In the past many intersections have already

been equipped with them, so in some cases it was simply a matter of their connection with the new system. Several main bicycle paths have also been equipped with this solution. These places called Advanced Stop Lines for cyclists, improving their safety on the road. In the end E–W road, along with the new ITS system have been launched on 31st October 2015 [20]. System launching was partial, with some of its subsystems introduced over time. Driver information electronic display VMS tables have been activated in December 2015 [8]. Another part of Driver Information Subsystem is a web page, showing information about accidents, traffic jams, road works, parking areas and weather. It has been launched in first half of February 2016 [15]. Currently, the system is still gathering the information and undergoes needed adjustments [15].

4. Problems during the system implementation

The work on ITS system had been coordinated with other construction projects conducted in the city. Main investment was the E-W road. In fact ITS system construction was part of the same project. The city had to deal with growing displeasure among citizens, who were already tired with extensive city transport network modernization in recent years. E – W road construction was particularly troublesome. Main intersections in the city were closed for two years, which led to serious congestion problems on alternative routes. What escalated this problem was the fact that the city ring road still was under construction and most of country north – south transit went through Lodz, to highway intersection situated north – east from the city. In order to reduce these inconveniences no entry edict for trucks over 12 tones was issued since March 2015 to December 2015 [20]. This in turn led to dissatisfaction in Lodz satellite cities, which had to deal with suddenly growing transit level [20]. Congestion level was further increased by the fact, that the city intersections had to be modernized, allowing their connection into constructed ITS system. Works on these intersections had to be organized in a way, which was felt least by drivers. Finally, the planned ending date for this project has been moved from September to November 2015 [17]. One of the reasons for the delay was the addition of additional construction works, requested by Lodz town council [17]. Another reason was the delay of E–W tunnel works, and its connection to ITS system. It was connected and finished by the end of October 2015, and testing took another month [23]. Official opening of the E – W road and ITS system happened on 31st October 2015 [20], and caused another problems. The traffic lights on one of most crucial intersections in Lodz, connecting Piłsudskiego street (E – W road) and Śmigłego - Rydza street (one of two main N – S roads) stopped working. This led to gigantic traffic jams in rush hours. This problem lasted for a few next days, until the malfunction was detected [18]. The problems did not spared the tram system in Lodz. Trams on one of roads connected to E – W road had difficulties with turning on to it, and created a few kilometers long traffic jam [19]. Again, the problem was created by traffic lights cycle and its bad optimization. Additionally, tram traction on E – W road suffered from voltage shortage [19].

Moving on further, the Passenger Information System was constructed as a part of Lodz ITS. Stops were equipped with special displays and supposed to show real time departure time. Unfortunately, by the end of first half of December, not all public communication means have been equipped with special GPS devices and the displays, instead of real time data, showed static timetable [15]. Another electronic display system, incorporated into Lodz ITS, also have some problems. As a part of the Driver Information System, nine VMS were placed on main routes, and started working in January 2016. Immediately, many drivers expressed the opinion that the table are unclear, and hard to decipher, especially for individuals who do not live in Lodz [17]. Tables show simplified network of main routes through the city. Different colors show traffic intensity, and travel time, based on the data gathered by system, is provided. In February 2016 ZDiT – the Board of Roads and Transport announced, that problematic graphical design format of the tables will be changed in following weeks [21].

Fig. 5. One of the VMS tables [16]

Lastly, a complex system like the one in Lodz needs time to be fully configured. ZDiT and Sprint company – main contractor of Lodz ITS system, announced that adjustment will take a few next months, giving an example of the city of Bydgoszcz, where adjustments of the ITS system on 50 junctions, which was also constructed by Sprint, took three months [15]. Step by step, the system learns about the city, and hopefully all problems will be eliminated and city traffic fully sorted out. Meanwhile, next infrastructure investments are planned.

5. Conclusion

The implementation of ITS systems is a very difficult task. Installation of such systems in cities often has to be parallely conducted with other ongoing municipal investments and so it was in Lodz. Despite the huge organizational and financial effort and commitment of many people, it was impossible to avoid problems at the start of this, currently Polish largest Intelligent Transportation System. The problems that occurred were typical for such cases described in many scientific papers and case studies. A team of people and institutions responsible for the implementation of ITS in Lodz, in these difficult situations, tried to work well to resolve the difficulties.

The analysis of the implementation phase of ITS in Lodz confirmed the theses included in a number of literature references, saying that in order to avoid problems during the starting period of such a system, it is necessary to observe the principles of project management and consult the proposed outcomes with all parties – a solution that will allow those parties to find potential weaknesses. The analyses carried out by authors, allowed them to propose potential changes in the implementation of ITS systems, which are contained below.

Social consultations conducted during the development of Lodz ITS system were insufficient. Such extensive project should be consulted with representatives of various parties, interested in efficient road network. The first one should be the police and the municipal police for Lodz, who can greatly benefit from the use of city-wide ITS. In the end, they were equipped with additional system workstations [13], but they did not get the chance to propose changes. Similar situation was with the regional Crisis Management Centre, coordinating emergency and municipal safety services. It is a very important entity in case of serious accident and catastrophes. Therefore, it should be able to use the system for its own purposes. It is most likely, that they can, but again, they could not yet propose changes. Last, but not least, the biggest interested party – drivers and passengers. Whereas passenger interest, in some parts, has been represented by the City Public Transport Company, drivers were neglected. Consulting them could prevent problems like bad design of VMS tables. Instead, a few weeks passed since the need to change it was acknowledged. In December and January, taxi drivers were asked for opinions [15]. They proposed a change in organization of some road lanes. Yet again, it would be more beneficial to consult them earlier, before the route was opened. Such consultations would also increase citizen awareness on the investment. Currently many people consider it as just another money sink, failing to comprehend future benefits.

Another improvement of the system will be an addition of even more cameras. As it was admitted by the Board of Roads and Transport representative, there are too few of them, leading to ineffective data gathering. Every future investment regarding intersections and traffic lights will require new cameras to be connected. This could have been prevented, by adding those additional cameras earlier, during overall reconstruction conducted by ITS system contractor.

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