ANALYSIS OF THE CRITERIA FOR THE FEASIBILITY OF INSTALLING TRAFFIC LIGHT REGULATION AT SINGLE-LEVEL INTERSECTIONS

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The need to introduce traffic light regulation at a specific intersection is determined using certain criteria based on the intensity of intersecting traffic flows and the occurrence of road traffic accidents (RTAs) at that intersection.

The intensity of intersecting traffic flows is regulated by relevant regulatory documents. In addition, traffic light control may be implemented in cases of high pedestrian traffic to places of attraction (cinemas, stadiums, large commercial and industrial facilities, etc.) or when schoolchildren cross the road in the vicinity of schools.

The negative consequences of motorization have recently affected most industrially developed countries. This has given rise to a number of serious economic, social, and environmental problems. These problems are particularly characteristic of large cities. One way to comprehensively solve these problems is to improve the efficiency of the transport system as a whole through the use of the latest technologies and the further intellectualization of automated traffic management systems and methods. The main method of such management today is traffic light control at intersections in the street and road network of cities.

In leading countries around the world (the US, Canada, Germany, Japan), the main parameter for introducing traffic light control is considered to be the intensity of traffic flows intersecting at the same level (Fig. 1) [1].

The organization of traffic at intersections is determined by the intensity of traffic flows at them (Table 1). If the traffic intensity at an intersection is relatively low, the intersection can function as unregulated. In this case, the effectiveness of such an intersection is determined by a sufficient number of lanes on the approaches to the intersection, as well as the channeling of traffic flows. When traffic intensity increases and reaches certain values, the organization of traffic at an intersection at one level becomes possible only with the use of traffic lights.

The introduction of traffic light control eliminates the most dangerous conflict points, which contributes to increased traffic safety. At the same time, the appearance of traffic lights at an intersection causes traffic delays on the main road, sometimes very significant due to the high traffic intensity characteristic of this road and the strict program control that is prevalent in our country today.

Table 1 - *Combination of critical traffic intensities on main and secondary roads, at which the introduction of traffic lights is recommended [2]*

Number of lanes in each direction		Traffic intensity on the main road in both directions , vehicles /hour .	Traffic intensity for the busiest direction of the secondary road , vehicles/hour
Main (busiest road)	Secondary (less busy road)		
1	1	750	75
		670	100
		580	125
		500	150
		410	175
		380	190
2 or more	1	900	75
		800	100
		700	125
		600	150

		500	175
		400	200
2 or more	2 or more	900	100
		825	125
		750	150
		675	175
		600	200
		525	225
		480	240

The feasibility of using traffic light control is determined based on an analysis of losses associated with vehicle delays at intersections. These losses depend both on the intensity of traffic in the straight and crossing directions and on the traffic light operating modes adopted at the controlled intersection [3].

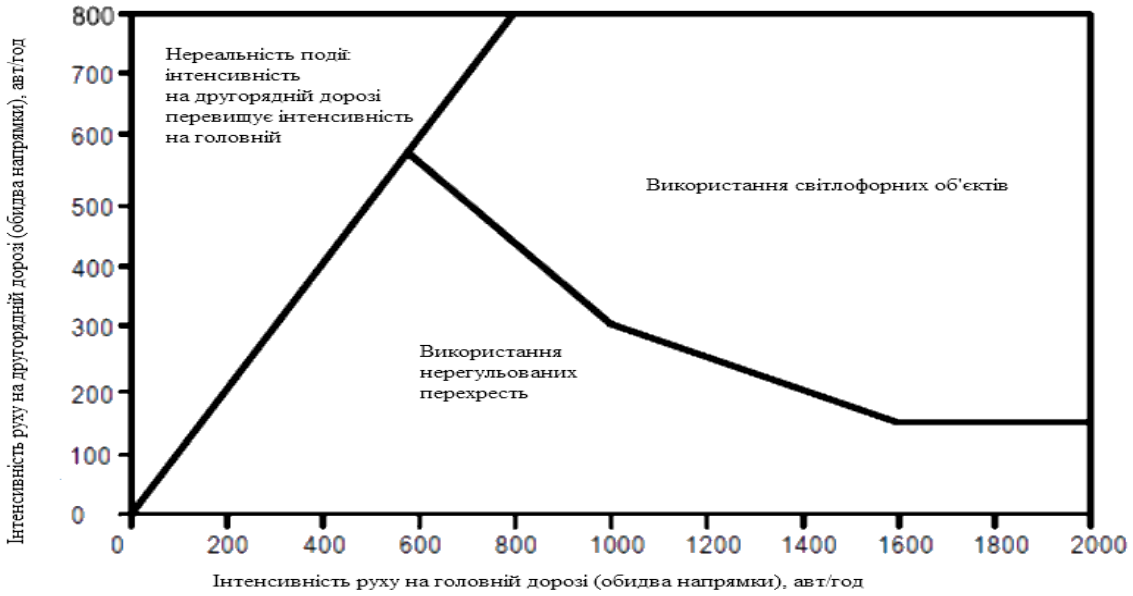

Figure 1 – *Conditions for the necessity of using traffic lights at intersections*

Thus, the introduction of traffic light control is not always justified and depends on many factors.

Currently, the saturation level of traffic lights in Ukrainian cities is significantly lower than in Western Europe, USA, Canada, Japan, and China. At the same time, the rapid increase in the number of vehicles in our country will inevitably lead to an increase in the saturation level of traffic control devices in Ukrainian cities.

In such a complex situation in our country and, in principle, throughout the world, with the rapid growth of the number of cars on the streets, there are practically

no clear standards and rules that would unambiguously in every situation, taking into account local conditions, answer the question “Is it necessary to install traffic lights at a particular intersection?”

In this regard, there is an urgent need to develop more precise or significantly improve existing standards (criteria) regarding the need to install traffic lights at intersections.

After analyzing the literature used by specialists in our country and abroad, it was found that the main parameters for the criteria for installing traffic lights are as follows [4]:

- intersection capacity (combination of critical intensities on main and secondary roads);
- accident rate at the intersection (number of accidents per year);
- magnitude of traffic delays;
- technical and economic analysis of intersection functioning (comparison of national economy losses at intersections with and without traffic light control).

The main objects and conditions, when the introduction of traffic light control at intersections is necessary, are as follows:

- various intersections at the same level;
- pedestrian crossings;
- railroad crossings;
- roads or sections of roads with reversible traffic;
- one-way roads;
- accident black spots;
- roadworks;
- various road conditions where the introduction of on-demand traffic lights is necessary.

The theoretical boundary conditions for the use of traffic lights can be determined, being based on the minimum losses, associated with delays at intersections, which depend on the intensity of traffic in the straight and crossing directions and the accepted traffic light operating modes. On the other hand, there is a

method for determining the need to introduce traffic lights at an intersection, which is based on determining the throughput capacity of the intersection, i.e., on determining the critical ratios of intensities on the main and secondary roads.

Assessing the effectiveness (service) of the transport and road complex as a whole and the regulated intersection in particular requires the availability of qualitative measures that characterize the level of traffic flow management.

The level of service (LOS) is a qualitative measure that explains the situation in the traffic flow, using characteristics such as speed and transportation time, freedom of maneuver, traffic flow interruptions, as well as the convenience and benefits of using a given section of the SRN [5].

Currently, there are several levels of service for each type of traffic management element, provided that there is a special procedure for analyzing this element.

Each level represents a range of traffic control states, as well as an assessment of the perception of this range of states by the driver (pedestrian, cyclist). For example, the level of service for a controlled intersection is determined by the amount of control delay, which leads to driver irritation, excessive fuel consumption, and increased correspondence time.

The delay experienced by the driver consists of a number of factors related to the geometric features of the intersection, the control mode, and the intensity of vehicle arrivals at a given controlled intersection [6].

The amount of traffic delay is determined as the difference in time when comparing the movement of a vehicle through a controlled intersection and free movement on the same section without the influence of traffic light control on the traffic flow.

The use of traffic light control at intersections is economically effective if the total time loss is less than the loss in uncontrolled traffic. At the same time, traffic safety requirements must be taken into account [7].

It is known that the total time loss in regulated traffic increases respectively to the duration of prohibitive traffic light signals and traffic intensity.

Summing up, it is possible to determine the limit values of these quantities at which the losses in regulated and unregulated traffic will be the same. By establishing this limit, it is possible to determine the critical traffic intensity at which the introduction of traffic light control is economically justified.

$$td(u)(N) = td(r)(N),$$

$$N = \text{function } (td(u), td(r)),$$

where N - critical traffic flow intensity for the economically justified installation of traffic lights, vehicles/hour;

td(u) - traffic delay at an unregulated intersection, s;

td(r) - traffic delay at a regulated intersection, s.

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WAYS AND TRENDS OF MODERN TRANSPORT LOGISTICS DEVELOPMENT

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The modern world is developing very fast. Every day, humanity faces serious problems and challenges. But at the same time, we continue to develop modern