1 INTRODUCTION

The City of Ljubljana is only one of the cities of Central and Eastern Europe threatened by an exceptional increase in the use of private vehicles for transportation and major changes in the transportation network that are reflected in patterns of development. This paper will focus on the proposal for building a new system of public transportation in Ljubljana from the conceptual starting point that land use significantly influences the mobility of the population.

1.1 What sustainable mobility means in geography and in Slovenia?

“Sustainable mobility” is not an established concept in the geographical sciences. Only in recent studies at the end of the 1990’s did the role of traffic in sustainable development begin to receive attention. The greater part of these studies was focused on urban traffic in the period when all the shortcomings in traffic planning in cities became most clearly evident. The increase in private transportation and the decline of public transportation along with the corresponding broader spatial, ecological, social, and economic problems stimulated geographical studies of cities and urban traffic on a wider scale. The primary goal of these studies revolves around the very broad aim of creating a safe, energy-efficient city system.²

To a large degree, the studies in Slovenia focused primarily on two important elements in the cities of special interest to geographers: land use and the transportation system. Thus the conviction slowly developed that these two factors are inseparably linked and that in urban planning the physical structure of the city must be connected with the transportation system. The first studies emerged that attempted to demonstrate the interaction between the physical structure of the city and traffic in the case of Slovene cities (Plevnik 2002). The turbulent debate over the new system of public transportation in the capital city of Ljubljana furthered studies of the relationships between land use in the city and traffic. Urban planners began to talk about “holistic” or integrated planning that would encompass the area of the city as a whole and not merely its elements and would thereby contribute to the more balanced and sustainable development of the city.
In many aspects, Slovenia lags behind the rest of Europe. The recognition that public transportation is the most important element for maintaining the city environment has not yet completely penetrated the awareness of the professional and lay public. The city authorities deal primarily with the symptoms of the excessive use of automobiles such as traffic jams, lack of parking, and pollution instead of solving problems related to sustainable mobility and accessibility. This paper will therefore try to evaluate all the variants of public transportation (including the existing transportation system) from the aspect of their relationship to land use and offer some basic orientation for urban planning.

1.2 Methodology

The central part of the study was to establish the degree of interaction of individual activities (land use) relative to the existing and planned system of public transportation. We determined the degree of interaction for residential land use (primarily newer apartment-building complexes, newer single-family housing areas, other residential areas), commercial land use (shopping centers, entertainment centers), and administrative, health care, educational, and industrial land use in the City Municipality of Ljubljana. For each category of land use we ascertained the spatial characteristics of public transportation: accessibility to stations and stops, time characteristics (frequency, regularity), travel time, route structure (course of routes, number of transfers), and other characteristics that significantly influence the quality of public transportation (usage, comfort, cost, etc.). The results of this analysis indicate the degree of interaction of public transportation with individual land use and thus offer us guidance in the development of the new system.

2 LJUBLJANA: CURRENT SITUATION

2.1 Primary problem: commuting habits and suburbanization

In the last decade, the commuting habits of Ljubljana area residents have experienced rapid and profound changes characterized by a steep increase in the motorization of the population, the decreased importance of public transportation, and increasing private transportation. Correspondingly, areas devoted to the road infrastructure are increasing: they already total 5.2% of all land in the City Municipality of Ljubljana, mostly due to
expressway ring roads and parking lots, whose construction has grown exponentially since the middle of the 1970’s.

Table 1: Selected characteristics of the City of Ljubljana

<table>
<thead>
<tr>
<th></th>
<th>1998</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of passengers using urban public transportation (millions)</td>
<td>106.9</td>
<td>102.4</td>
<td>99.32</td>
<td>95.42</td>
<td>93.89</td>
</tr>
<tr>
<td>Change</td>
<td>-4.47</td>
<td>-3.15</td>
<td>-3.9</td>
<td>-1.53</td>
<td></td>
</tr>
<tr>
<td>Land use for road transport (hectares)</td>
<td>1,246</td>
<td>1,253</td>
<td>1,255</td>
<td>1,263</td>
<td>1,414</td>
</tr>
<tr>
<td>Change</td>
<td>+7</td>
<td>+2</td>
<td>+8</td>
<td>+151</td>
<td></td>
</tr>
<tr>
<td>Motorization (automobiles per 1,000 inhabitants)</td>
<td>448</td>
<td>463</td>
<td>464</td>
<td>470</td>
<td>475</td>
</tr>
<tr>
<td>Change</td>
<td>+15</td>
<td>+1</td>
<td>+6</td>
<td>+5</td>
<td></td>
</tr>
</tbody>
</table>

From the viewpoint of the sustainable mobility of the population, a major drop in the use of public transportation can be observed: in the 1970’s more than half of commuting was done using public transportation, but barely 17% in 2000. It is interesting to compare the commuting habits of Ljubljana and Amsterdam commuters: the average Ljubljana resident owns fewer automobiles, makes more trips daily (LJ: 4.6; AMS: 3.9), uses public transportation less (LJ: 17%; AMS: 35%), and uses private transportation more (LJ: 70%; AMS: 40%). Along with the greater use of automobiles, the average occupancy of automobiles is characteristically low (between 1.2 and 1.5 commuters).

The changes to commuting habits in Central and Eastern European countries cannot be marked as a delayed process that was experienced by Western European countries following World War II. Ljubljana, Prague, and other “post-socialist” cities, experienced the transition to liberal capitalism considerably more intensively and over a shorter period, a process also reflected in dynamic motorization and the rapid change of settlement patterns, particularly the suburbanization that advanced urban sprawl in only a few years. Individual mobility and suburbanization have a close cause-effect relationship, and therefore commuting habits cannot be separated from changes in the patterns of land use.
2.2 Existing system of public transportation and its interaction with land use

Since the 1970’s when the tram system was shut down, Ljubljana has had a bus system for public transportation. From the very start of its operation, the number of passengers carried has been dropping, falling from 200 million to 100 million in thirty years. It is interesting that the system has hardly changed since the beginning in terms of routes, schedules, or space. Over thirty years, the structure of public transportation has only experienced “face-lifts” while the structure of the city from the spatial and social viewpoints has changed profoundly.

According to the methodology applied, the highest degree of interaction is shown for the newer apartment building complexes and administrative, educational, health care, and industrial areas. The locations of these areas correspond to expectations in the immediate city center and along the main city traffic arteries. The lowest degree of interaction between public transportation and land use is evident for the newer commercial centers on the outskirts with their diverse entertainment parks, “mega” movie theatres, and distinct orientation toward the parking infrastructure. It is characteristic of these areas that in spite of advantageous coverage with bus stops, the bus schedules and routes are unsuitable and are therefore distinctively inferior compared to the use of automobiles. A low degree of interaction is also evident for the newer single-family housing areas situated mostly in satellite settlements and on the outskirts of Ljubljana that are the consequence of the exodus of the wealthier population looking for a residential area of better quality (or its illusion) outside the crowded city. In most cases, such areas are beyond the reach of the public transportation system, which makes their inhabitants totally dependent on the automobile.

This situation is easy to explain: in the “golden age” of urbanization in Ljubljana during the 1970’s when densely populated apartment building complexes and industrial and service zones were developed most intensively, the new system of public transportation was also created. That was the period of social planning in which public transportation played an important role, and therefore all the new areas were connected by public transportation. Toward the end of the century, mainly after the change of the political and economic system in the 1990’s, this practice died away completely; furthermore, the previously mentioned processes (suburbanization, motorization) grew and additionally reduced the
role of public transportation. The current state of public transportation in Ljubljana is not enviable: survey results indicate that public transportation is only used by those of the population who cannot afford an automobile or do not drive. More than two thirds of the passengers are school children or retired people, while workers, tourists, shoppers, and others are in the minority and mostly use automobiles instead. People living in the city center and those with lower incomes most frequently use public transportation.

3 LJUBLJANA: PLAN
3.1 Learning from mistakes and the goals of the new system of urban public transportation

Two years ago, Ljubljana city planners wrote, “Developmental and traffic problems are a sign that the city is ripe for a quality shift in planning the traffic infrastructure and the activities connected with it.” It was generally agreed that the bus system could not compete with the automobile and therefore the future public transportation-system must be based on the so-called “light railway” (tram system) that will be extended to meet the already existing regional railway outside the city (i.e., linking the urban and regional railways). A secondary bus system will supplement this network to cover areas the light railway does not reach.

The primary goal is the integration of the regional and urban public transportation systems, thus meeting the needs of the suburban population, who, according to the figures, use public transportation the least (only 13% of all commuting is done using public transportation) and who contribute most to the traffic problems of Ljubljana. “Park and ride” transfer points will be built on the outskirts of the city where commuters can change from automobiles or the regional railway to the urban railway. The latter will run on the main city thoroughfares and have a star shape; all the lines will end at the main railway station, which will become the hub for the urban, suburban, regional, and international public transportation systems. The question remains unresolved regarding an underground or surface line for the urban railway in the center of the city where all the lines of the urban railway would meet. An underground network would be considerably more expensive but at the same time would mean much higher travel speed and better accessibility for passengers. A secondary bus system will supplement the urban railway and fill gaps in the accessibility of stops. Thus the center of the city will be connected by a network of
minibuses, while city lines will be connected by bus lines bringing commuters from the immediate surroundings of Ljubljana directly to the urban railway where the secondary transfer points will be built.

Figure: Concept of planned system of public transportation in Ljubljana

The planners of this type of public transportation mention three key positive points of the system: quality (shorter travel times, regular frequency, comfort), coverage of areas (more than 90% of the population of Ljubljana will be within 500 meters of a station or bus stop), and integration (connection of city and intercity transportation).

3.2 Evaluation of the planned system of public transportation relative to land use

From the technical point of view, the planned public transportation system is modern and feasible financially and from the construction aspect. However, questions that the planners of the system never asked themselves but which must be answered are of key importance: will this type of public transportation system change commuting habits; will it be attractive enough to divert commuters from automobiles to the railway; and will it connect the parts of the city that produce the greatest flow of commuters?

The first two questions are difficult and will probably be answered only after the introduction of trams. Along with technical solutions, alternatives generally offered to average commuters who prefer to use automobiles should be studied. The study of the future public transportation system relative to land use is of great importance. One reason for the unsuitability of the existing public transportation system is the fact that it is not capable of connecting the areas that create the greatest need for commuting (new commercial and entertainment centers, new single-family housing areas), and conversely the process of planning land use should take public transportation into consideration as a location factor. In practice, this should mean that the system of public transport can not and should not blindly “follow” land use but that land use should also adapt to the existing
public transportation system: it is necessary to begin to limit the planning of traffic-generating activities outside the reach of public transportation.

This is also the primary starting point of this study as we are attempting to evaluate the future public transportation plan from two viewpoints: (1) which activities will be in subordinate position relative to the plan, and (2) what locations relative to the public transportation plan could be used to a greater degree as locations of traffic-generating activities?

The study indicated that the surface variant of the urban railway would cover various types of land use in the city of Ljubljana quite well: in contrast to the existing system, the new single-family housing areas, commercial areas, and educational activities would become better connected, and most of all, connections with suburban transportation systems would be better. Only the connections with industrial areas would be worse, but these areas are losing significance and do not belong among traffic-generating activities. The underground variant of the planned public transportation system in Ljubljana would be much more expensive (by 40%) and the interaction with land use would not change significantly; only the criteria of accessibility to stations and stops in the center of the city would improve.
Table: Comparison of selected characteristics (spatial variables and interaction with land use) relative to the public transportation system in Ljubljana

<table>
<thead>
<tr>
<th>Spatial variables of public transportation</th>
<th>public transportation bus system (existing)</th>
<th>Surface variant of urban railway and supplementary public transportation bus system</th>
<th>Surface and underground variant of urban railway and supplementary public transportation bus system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessibility to bus stops</td>
<td>++ City center + City outskirts</td>
<td>+ city center + city outskirts</td>
<td>++ City center + city outskirts</td>
</tr>
<tr>
<td>Route structure</td>
<td>- Distinctly diametrical routes, few transfers, longer travel time</td>
<td>+ Mixed diametrical-tangential routes, more transfers, shorter travel time</td>
<td>+ Mixed diametrical-tangential routes, more transfers, shorter travel time</td>
</tr>
<tr>
<td>Time structure</td>
<td>--</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Financial costs</td>
<td>+</td>
<td>300 million €</td>
<td>420 million €</td>
</tr>
<tr>
<td>Travel speed</td>
<td>- 10 -15 km/h</td>
<td>+ 25 km/h</td>
<td>++ 30 km/h</td>
</tr>
<tr>
<td>Interaction with suburban transport</td>
<td>--</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Interaction with new apartment building complexes</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Interaction with new single-family housing areas</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Interaction with industrial zones</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Interaction with commercial centers</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Interaction with educational activities</td>
<td>+</td>
<td>++</td>
<td>++</td>
</tr>
</tbody>
</table>
In spite of everything, several “grey spots” or areas with inadequate connections of traffic-generating activities with the public transportation system would remain, for example, the largest shopping and entertainment area in the eastern part and the densely populated apartment building complex in its immediate vicinity, where the criteria of accessibility to public transportation stops would not be satisfied.

If we therefore want to ensure the sustainable mobility of the city population, we must ensure that all areas that require commuting are properly connected to the network of public transportation. Such an established system should itself later become a location factor in planning land use in the cities. In practice, this means that each activity that creates traffic currents should follow the public transportation network. Integrated city planning plays an important role here and must find locations in the city that will enable the sustainable mobility of the population. Possibilities appear primarily in the renovation and restructuring of several already built city areas and in the search for new areas that offer possibilities for the sustainable mobility of the population. In the case of Ljubljana, we found such locations in the old city core, in the industrial zone in the northwestern part, and in individual empty areas along radial city streets as well.

4 CONCLUSION
This study attempted to evaluate the public transportation system relative to land use to achieve a mobility of the population that would not present an obstacle to the development of the city. From the viewpoint of the sustainable mobility of the population, we can evaluate the planned public transportation system positively in spite of some deficiencies that should be eliminated. We primarily wished to draw attention to the fact that a city like Ljubljana needs the integrated planning of city transportation and land use. To achieve the sustainable mobility of the population, two basic conditions must therefore be fulfilled:

- (1) the establishment of an effective system of public transportation that will enable optimal mobility for commuters and connect all traffic-generating activities in a fashion that will “divert” commuters from private to public transportation;
- (2) with the successful establishment of an optimal public transportation system, all further planning interventions in the city should take the existing system into consideration and “follow” the course of public transportation (Dutch practice of ABC locations).
The results of the study therefore lead city planners to:

- (1) establish a better connection between certain points in the city that are currently insufficiently covered in the public transportation plan (relative to accessibility to stops, travel times, and other variables given in the methodological starting-points);
- (2) plan future land use in the city in accordance with the concept of sustainable mobility and therefore consider accessibility to public transportation as a factor in locating activities in the city. As a rule, traffic-generating activities should be located in areas that are best accessible by public transportation; therefore, it is necessary to elaborate new spatial plans and define areas where concentration will occur and areas that so far have not been sufficiently exploited but are located within easy access of public transportation.

The question of whether the population will give up their automobiles for trams will only be answered in twenty years. However, the commuting habits of the population of Ljubljana will probably have to change considerably sooner; otherwise, trams will only be an expensive toy while traffic jams will continue to choke the streets.

---