Sustainable transportation systems

I. Cruzado

*Department of Civil Engineering and Surveying, University of Puerto Rico, Mayagüez Campus*

**Abstract**

Sustainable Design, also known as sustainability, has become a key concept in the 21st century. The concept became indispensable when society realized that traditional planning methods had negative consequences on the environment, like pollution and the excessive use of natural resources. Professionals specializing in different engineering areas decided to improve planning methods in order to avoid future generations focusing on the search for solutions to the problems caused by traditional planning. In order to achieve a sustainable community, changes in its transportation systems must be made. A successful promotion about the negative consequences of private automobile dependency and the benefits of self-mobility is the first step that transportation engineers must take before designing sustainable transportation systems.

*Keywords: sustainable transportation systems, sustainability, sustainable design, mass transit system, self-mobility, traffic calming.*

**1 Introduction**

Traditional planning methods resulted in problems to the environment, such as air and noise pollution, and even in health problems. When applied to transportation systems, the traditional methods resulted in traffic congestion problems, saturating highways with a high demand of vehicle volume. The “sustainable design” term, when related to transportation systems, does not considered to the use of the private vehicle. This report intents to inform planners, as well as every society, about the changes that have to be made in order to achieve a transportation system that could be categorized as sustainable and thus, achieve a sustainable community.
2 Sustainable design and transportation

The concept of sustainable design covers a broad field of engineering, from energy sources to community development. The World Commission for the Environment and the Development of the United Nations defines sustainable design as “the ability that has the present generation to use the available resources and satisfy present needs without compromising the ability of future generations to satisfy their own needs”. Many professionals believe that this definition is ambiguous and that the term “sustainability” will never be properly defined. The word “development” represents the continuous growth of population and industry, while the concept of sustainable design does not include the idea of equilibrium with the environment. It is a fact that the development of technological systems impacts the community and the environment. Nevertheless, the concept has been defined as a known international situation that needs an immediate solution.

The high rate of population growth, combined with traditional planning methods, has resulted in high levels of traffic congestion, which leads to both air and noise pollution and other environmental problems. While population continues to grow, the existing transportation systems cannot accommodate the traffic demand. The development of new transportation systems, designed with traditional planning methods, is not considered a viable option due to the fact that it will accommodate the traffic demand for a short period of time. The continuous population growth, resulting in an increase of vehicle trips, needs an equilibrium between the existing transportation systems and the future ones that have not been developed. This equilibrium has to satisfy the population’s needs while preserving the nature resources. Any planning design must possess a balance between the type of community and the different transportation systems.

In order to design a sustainable community is necessary to make changes in the existent transportation systems, which could lead to changes on terrain use. The systems to be developed would have to complement the present systems without destroying them. The principal source of energy used for transportation systems are non reusable resources. In order to minimize the use of these resources, a reduction of trips made by private vehicles is necessary. The impact on the environment could be minimized if more dense and compact communities were developed. The primordial impact would be a reduction of private vehicle use, resulting in a reduction of vehicle trips and vehicle miles. To achieve this goal it is necessary to promote different land uses, but more important would be the promotion of different transportation methods. Informing the communities about the negative effects of private vehicles is the first step in order to achieve an effective promotion of sustainable transportation systems.

3 Negative effects of the private vehicle

The non-sustainable planning of the transportation systems has resulted in many negative consequences. In the past, high vehicle demand was resolved by numerous transportation projects without considering the effects they may have
had in future generations. In the present, transportation systems cannot accommodate the traffic demand. The addition of new lanes and the construction of new highways are not considered viable solutions. This situation results in traffic operation, environmental, and health problems, without excluding the little interest from the communities in alternate transportation systems.

Traffic congestion, although resulting in late hours and personal frustration for the drivers, also causes numerous environmental problems. The high number of vehicles cruising through the highways results in high levels for both noise and air pollution. Toxic emanations have become the problem of greatest importance for the preservation of natural resources. Many solutions, including the design of hybrid vehicles, have been developed to solve this problem. The excessive noise caused by the numerous vehicles has resulted in unattractive communities for the residents. The short-time solution for noise pollution in communities is the development of noise barrier walls.

The great dependency on private vehicle has resulted in a reduction of self-mobility methods. Statistics from the United States Department of Transportation indicate that, from 1975 to 1995, there was a 42% reduction of adults who walk to destinations less than a mile away. Young adults have acquired this kind behavior when it comes to home-school trips. Thirty years ago, more than 65% of young adults used to walk or bike to school, compared to only 10% of today kids that choose this type of transportation method. This reduction in self-mobility has not been balanced with other physical activities, which has resulted in health risks to young adults. Statistics developed by the American Medical Association show that 60% of young Americans are obese. Although the statistics for children are of less magnitude, they are equally alarming. Studies show that 25% of children of ages between 2 and 5 are obese. More alarming, 60% of children who are overweight have at least one risk factor related to heart disease. New transportation systems that substitute the use of private vehicles are needed in order to reduce all these negative consequences in any community.

4 Alternative transportation methods

Transportation systems in any community must be efficient for the present generation and, if those changes are implemented in order to satisfy future generations, the changes should not sacrifice the existent natural sources. Due to the great dependency on the private vehicle, especially in United States and Puerto Rico, two transportation systems could be identified in order to reduce vehicle trips. A successful promotion of mass transit systems, like light rail trains, and the promotion of self mobility, like walking and bicycling, could be the key concept to achieve a sustainable community.

4.1 Mass transit systems

The substitution of private vehicle trips by trips made by buses or subways may result in a reduction of traffic volume. The subway is the only mass transit
A sustainable system is considered due to the fact that highway systems are not involved for its use. The space used for highways could be used for the preservation of natural resources. For non-walking distances, the subway is preferred for the development of a sustainable community. Several professionals have expressed that every modern society must have this type of transportation system in its infrastructure.

The island of Puerto Rico, with an area of 3515 square miles, has a population of approximately 3.8 million people. The metropolitan area of Puerto Rico, located on the north coast around San Juan, Puerto Rico’s capital, includes several cities with high population density (Figure 1).

These cities are the home for approximately 40% of the island’s population, and in them are concentrated 63% of Puerto Rico’s employments [5]. These factors are the reason why Puerto Rico is among the countries with a high density of vehicle per miles. Statistics indicate that Puerto Rico’s metropolitan area generates more than 3.2 daily million trips. These numbers, and the projected ones, indicates the need for an efficient mass transit system in the island’s metropolitan area. The “Tren Urbano” (Urban Train) will be the first light rail mass transit system in Puerto Rico.

The Tren Urbano will give access to the metropolitan area once finished its construction. On April 2004 Tren Urbano’s first phase is expected to be completed and efficiently working. This first phase will cover 11.8 miles (17.2 kilometers) giving access to five communities: Guaynabo, Bayamón, Río Piedras, Hato Rey, and Santurce (Figure 2, dark blue trajectory). It is estimated that traffic congestion will be reduced to levels previous to 1990. Figure 2 also shows all phases for the complete mass transit system Tren Urbano, which will give a connection in multiple directions among all metropolitan area. It is estimated that in the year 2010 the Tren Urbano will consume the 45% raise in private vehicle trips projected for the mentioned date [5]. The Tren Urbano will be the first attempt to achieve a sustainable community among the cities that composed the metropolitan area of Puerto Rico. Other high population density communities in Puerto Rico, like Ponce, Arecibo, and Mayagüez, each presenting traffic congestion problems, must be studied in order to decide if mass transit systems are needed for those communities.
4.2 Self-mobility and traffic calming

Although the Tren Urbano could reduce the use of the private automobile for long distance trips, it does not attempt to reduce the number of trips made by private automobile which are less than one mile. One of the reasons why the people of Puerto Rico use their automobile for short trips is the small security in their urban communities. The need for sidewalks, especially in small communities, has led to the perception that children are not safe while walking to and from school, although the concept that children are safer when parents drive them to school is not well defined. Statistics show that the number one reason for children 4 to 14 years old deaths in the United States is car accidents [6]. In order to achieve a sustainable design for the communities is necessary to minimize the number of trips by private automobile with an efficient self-mobility promotion. Redesign pedestrians routes is extremely important in order for them to be attractive and safe for people. Traffic calming techniques may be the answer for a sustainable community.

Traffic calming is the method for changing driver behavior by changing geometric features in highways. The method uses a combination of physical measures which reduce the negative attitude on drivers while improving traffic conditions for pedestrians and bicycles. The high number of high speed vehicles can be minimized by implementing speed humps, traffic circles, and changes on highway widths. The following pictures show some of the traffic calming techniques which alter driver behavior while improving the safety for pedestrians.

Picture 1 shows a speed hump, the most common technique for altering driver behavior causing them to reduce their vehicle speed. This technique could be
even more effective if combined with a crosswalk, like shown in Picture 2. By elevating roadways on high pedestrian communities, it is achieved that drivers reduce their speed exactly before the crosswalk, though improving pedestrian safety. Techniques shown in pictures 3 and 4 also improve pedestrian safety in implemented on crosswalks. Drivers tend to reduce vehicle speed on narrow streets. By reducing street width just before the crosswalk, drivers will reduce their speed in presence of pedestrians while offering pedestrians less distance to walk. By adding a deflector island between lanes, the same behavior is achieved, but this time a refugee space is offered to pedestrians.

The effective implementation of these techniques will result in a reduction of car-pedestrian accidents and in safer and attractive routes for non-motorized users. It is also important to provide wide sidewalks and proper night illumination in order to promote safe self-mobility. The implementation of traffic control devices, such as pedestrian detectors and actualized traffic signals, could also be effective for a sustainable community.

5 Summary

Great dependency on private automobile use, in both United States and Puerto Rico, is the reason why many drivers suffer from traffic congestion problems. In order to reduce the number of trips made by private automobile is necessary to promote alternate transportation systems. The light rail train, preferable of underground type, is the only mass transit system considered of sustainable
character. Every modern society should have a light rail system in its infrastructure in order to offer a sustainable transportation system for those trips that are greater than one mile. For short distance trips, self-mobility must be promoted by implementing traffic calming techniques in order to improve pedestrian safety and offer attractive pedestrian and bicycles routes. An effective promotion of both types of transportation systems must include information of the negative consequences of the excess use of private vehicle. This promotion should also include information about the benefits of increasing physical activity and information about health and environmental problems in order to achieve a sustainable community.

References


