Develop a Demand-Based Intelligent Parking Management System (IPMS) to Implement in Urban Areas

Methmal Dissanayake[1], Saman Bandara[2]

Abstract

Parking congestion is a major issue in urban areas globally, particularly in areas with high-demand. However, less crowded parking spaces can be discovered in low-demand areas, and sometimes, parking demand varies significantly over time depending on roadside land use. Traditional parking management systems often rely on sensors and cameras, which can be costly and require complex infrastructure. In recent years, the emergence of crowdsourced data has opened up new possibilities for parking management. This research aims to develop an efficient Intelligent Parking Management System (IPMS) based on local demand that utilizes an integrated approach for urban roadside parking strategy using Galle Road Corridor in Sri Lanka as a case study area due to the well-organized existing parking slots in this particular road section. The strategy combines non-sensor-based crowdsourcing methods, mobile applications, and data analytics to optimize parking availability and enhance the overall parking management system. Through the literature review, an exploration was undertaken to identify cost-effective parking management solutions that do not rely on sensor/camera-based methods. The methodology includes several key components. As an initial consideration, a mobile application system should be designed to enable users to access real-time parking information and check parking availability using their smartphones. Thereby, users can receive information on parking availability in the surrounding area before entering their desired parking location. The strategy included a coding system for easily identifying the parking slots and ensuring accurate and reliable data. Each roadside parking space is assigned a unique code, which is prominently displayed. If a user enters the parking space, the mobile application will mark the parking slot as unavailable. When the user exits the parking slot, they have to pay their parking fee, and the parking space is then re-marked as available. Similarly, through a mobile application, any user can check the availability of a desired roadside parking location. If the desired parking slot is full, this strategy also provides information about adjoining roadside parking locations. To achieve the objectives, it is necessary to identify on-street parking demand in a particular location. The strategy also utilized data from a variety of sources, including historical parking data from traffic data of Municipal Councils, to analyze past parking demand patterns. A road section in the Galle Road corridor was divided into a number of zones, and parking usage was analyzed by identifying demand, rush hours, and day variations of parking through a survey. To retrieve real-time vehicle average speed data, Google Maps API services are used, which are then combined with data gathered from a physical survey to verify demand in a particular road segment. These data assist in anticipating parking demand and optimizing parking allocation in advance. The utilization of parking spaces during the day, along with the types of vehicles parked, was monitored in the road sections. Parking pricing mechanisms can be used to optimize parking distribution further. Parking fees can be adjusted based on demand and availability by implementing dynamic pricing strategies. At specific times, a fixed parking rate is in effect, with the option to offer discounted rates during peak hours to encourage drivers to choose lower-demand parking areas. This pricing mechanism, which can also be conveniently displayed for the users through a mobile app, allows vehicles to be distributed more evenly across the parking

infrastructure. This would not only reduce congestion in high-demand areas but also encourage the utilization of idle parking spaces. In conclusion, the evaluation results measure the strategy's effectiveness and offer valuable insights and recommendations for policymakers, urban planners, and parking operators aiming to develop efficient and sustainable parking management systems in urban roadside parking.

Keywords: *Intelligent Parking System, Demand-Based Parking, Parking Management*

Authors Details.

1. Postgraduate Student, Department of Civil Engineering, Faculty of Engineering, University of Moratuwa. dissanayakedmsmb.23@uom.lk
2. Senior Professor, Department of Civil Engineering, Faculty of Engineering, University of Moratuwa. bandara@uom.lk