



## Parking Management in Supporting Sustainable Development: Systematic Literature Review

Immanuel Panusunan Tua Panggabean<sup>1</sup>, Sirojuzilam<sup>2</sup>, Suwardi Lubis<sup>3</sup>, Agus Purwoko<sup>4</sup>

<sup>1</sup>Program Studi Doktor Perencanaan Wilayah, Universitas Sumatera Utara (nuelgabe@gmail.com)

<sup>2</sup>Fakultas Ekonomi dan Bisnis, Universitas Sumatera Utara (sirojuzilam@usu.ac.id)

<sup>3</sup>Fakultas Ilmu Sosial dan Ilmu Politik, Universitas Sumatera Utara (suwardilubis@yahoo.com)

<sup>4</sup>Fakultas Kehutanan, Universitas Sumatera Utara (agus9@usu.ac.id)

**ABSTRACT.** Parking Management is the continual process of selecting and implementing parking policies to make the strategies take effect. The paradigm regarding parking management needs to be reviewed further from several aspects, such as planning, evaluation, and strategies including the relationships and interactions between users – communities, and the environment, as well as aspects of management, including the sustainability of parking management in the future. Through a systematic literature review of Scopus indexed articles, this study could identify concepts and theories that can formulate a new paradigm of parking management. From the sustainability theme, exploring parking management should be carried out with a special research approach taking into account the different characteristics or behaviours of drivers, as well as destination profiles and the affected communities.

**KEYWORDS:** parking management; sustainability; systematic literature review

### 1 INTRODUCTION

Parking has become an overlooked problem not only in Indonesian transportation planning but also in policy, especially in big cities like Medan. At the national or local levels, there has never been a detailed parking rule. In the five cities of Jakarta, Bandung, Surabaya, Yogyakarta, and Medan, there are only a few explicit regulations on specific parking restrictions. The development of rail transit systems and community parking for tourist areas is aided by park-and-ride facilities. Federal laws and subordinate regulations that completely influence control of on-street and off-street parking have changed very little in the last decades.

Traditionally, parking issues are addressed solely within this public transit, despite the fact that parking measures have a significant impact on the operation of other road transport urban systems. This is supported by the fact that neither central authority is in responsible of road infrastructure, public transportation, and car park in many cities and towns. In order to find an optimal solution, a planner must prepare the plan in more detail and integrated it with other decision-makers. (Litman, 2003).

### 2 LITERATURE REVIEW

We begin with the concept of emphasizing sustainable development and its complexity to define the parking management approach. In addition, we categorize the position and role of the continual transportation system, highlighting its goals and directions, to aid in the proper understanding of parking positions in the holistic strategy. This established the groundwork for incorporating the parking technique in the future. Aside from the procedure for defining a parking method.

Despite the increasing number of papers published in recent years, an overall conceptualization of parking policy is still lacking. Bridging this gap by analyzing the evolution of policy. (Mingardo, 2015) parking should be considered in the context of transportation, land use, the environment, and the economy.

Strategic parking space development is regarded as the most effective solution for reducing urban congestion. The interactions between land use and parking have been quantified in order to investigate

their emission impacts on traffic congestion. The Extra CO<sub>2</sub> Pollution Index, a novel non-dimensional ratio introduced in this study, estimates pollutants in minimum and maximum parking lots, increasing traffic jams in residential districts while negatively affecting compact land use toward self-sufficiency. (Shen, 2020).

Real-time parking locations are expected to assist drivers in finding a parking space more quickly, reducing parking search traffic. The aggregation of parking slot information from crowdsourcing solutions such as probe vehicles and mobile phone applications is one possibility for creating such maps. Investigates the use of sensor information from San Francisco to estimate parking allocation using spatial methods. To begin, temporal similarities in parking slots are evaluated for various aspects such as time of day and number of parking areas available based on the distance to reveal the parking characteristics. Interpolation methods are then investigated in order to quantify parking availability in non - observable road segments. (Bock, 2016).

According to estimates, vehicles cruising for on-street parking contribute to 30% of urban traffic congestion. parking on the street Vehicles cruising for on-street parking are estimated to contribute 30% of urban traffic congestion. On-street parking information systems are becoming increasingly popular as a service to help reduce on-street parking search time and, as a result, traffic congestion. Despite these prediction models' service offerings, on-street parking behavior. Concentrates on parking behavior analysis by capturing on-street parking dynamics, which can provide a better understanding of a city's parking contextualization. (Gomari, 2021)

With a case study in Nanning, this study investigates the impact of on-street parking price adjustments. Data from parking meters and surveys are used to assess the impact of the policy intervention on parking demand and user satisfaction, respectively. People believe that the parking price has increased since the policy change, that the parking lots are closer to the final destination, and that the parking lots are more vacant. Following the policy intervention, on-street parking users have higher incomes. (Mo,2021)

The analysis results revealed that surface parking location patterns between Kyoto and Philadelphia differed significantly. Kyoto has many small-scale surface parking lots under 0,05 Ha, while Philadelphia has large-scale surface parking lots in its historic district. Although the spatial patterns cause urban landscape discontinuity in both cities, but it makes a greater extent in Kyoto. Municipal authorities with historic significance should prepare parking areas as part of their heritage conservation plans. (Oba, 2020)

### **3 METHODOLOGY**

A systematic literature review was conducted to evaluate the scientific development of the concept of parking management. The process of implementing this systematic literature review includes: identifying, evaluating, and synthesizing the results of previous research with several defined categories. The standard used to perform knowledge mapping is to use the PRISMA standard (M. J. Page,2021).

The first step is to look for articles related to parking management. To ensure the quality of the articles, the database used is Scopus which has been recognized as a reputable journal publication database. Articles are searched using the keywords "parking" and "parking management". The article category is limited to the period 2011 – 2021, and there are 37,692 articles identified related to the discussion on parking and parking management. Then the selection of articles was narrowed down to the period 2015 – 2021 and produced 17,478 articles. The first screening was carried out based on the discussion in the title and abstract, the database that did not discuss parking and parking management was discarded as many as 20,214 articles. Most of these articles deal with parking and parking management separately. The second screening narrowed to publishers focus on Transportation, Cities and Sustainability. The database assessed for eligibility as many as 2,312.

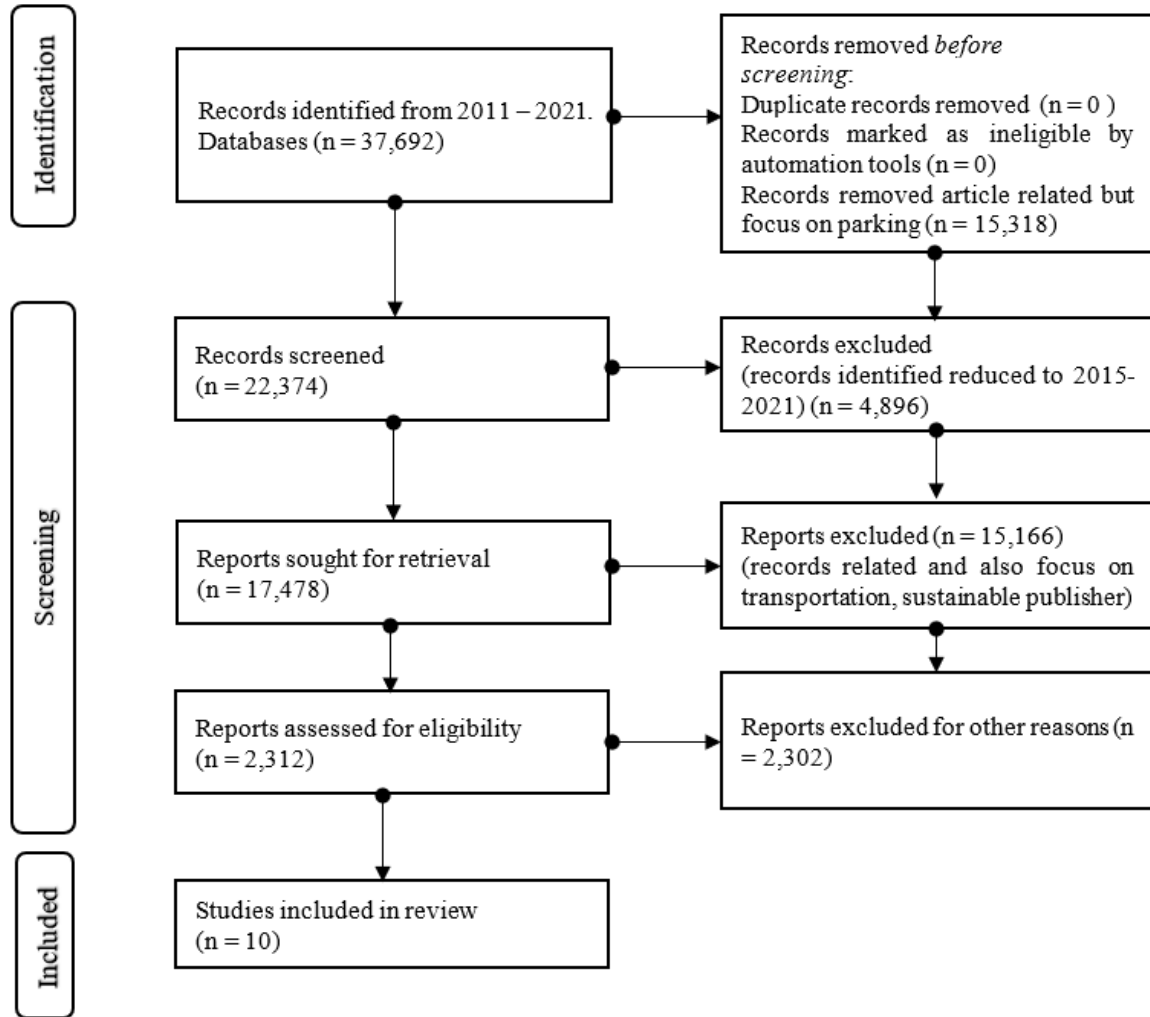


Figure 1: PRISMA Standard for Identifying Study Databases

Therefore, sources in the form of notes are also eliminated so that the number of parking management articles that are the focus of discussion in this study is 10 articles as follow:

Table 1: List of Selected Articles

Authors, Years	Title	Journal
(Bock, S, Sester, M, 2016)	Improving Parking Availability Maps using Information from Nearby Roads	Transportation Research Procedia
(Fiez, T, Ratliff, L.J., 2019)	Gaussian Mixture Models for Parking Demand Data	IEEE Transactions on Intelligent Transportation Systems
(Gomari, S, et.al., 2021)	Cluster Analysis of parking behaviour: A case study in Munich	Transportation Research Procedia
(Gruyter, C. D., et.al., 2020)	Can high quality public transport support reduced car parking requirements for new residential apartments?	Journal of Transport Geography
(Levy, N, Benenson I, 2015)	GIS-based method for assessing city parking patterns	Journal of Transport Geography
(Mingardo, G., et.al., 2015)	Urban parking policy in Europe: A conceptualization of past and possible future trends	Transportation Research Part A
(Mo, B., et.al., 2021)	Impact of pricing policy change on on-street parking demand and user satisfaction: A case study in Nanning, China	Transportation Research Part A

Authors, Years	Title	Journal
(Oba, T, Iseki, H.,2020)	Transportation Impacts on Cityscape Preservation: Spatial Distribution and Attributes of Surface Parking Lots in the Historic Central Districts	American Society of Civil Engineers
(Shen, T, et.al., 2020)	How does parking availability interplay with the land use and affect traffic congestion in urban areas? The case study of Xi'an, China	Sustainable Cities and Society
(Wang, S. et. Al., 2021)	Optimal parking management of connected autonomous vehicles: A control-theoretic approach	Transportation Part C

#### 4 RESULTS AND DISCUSSION

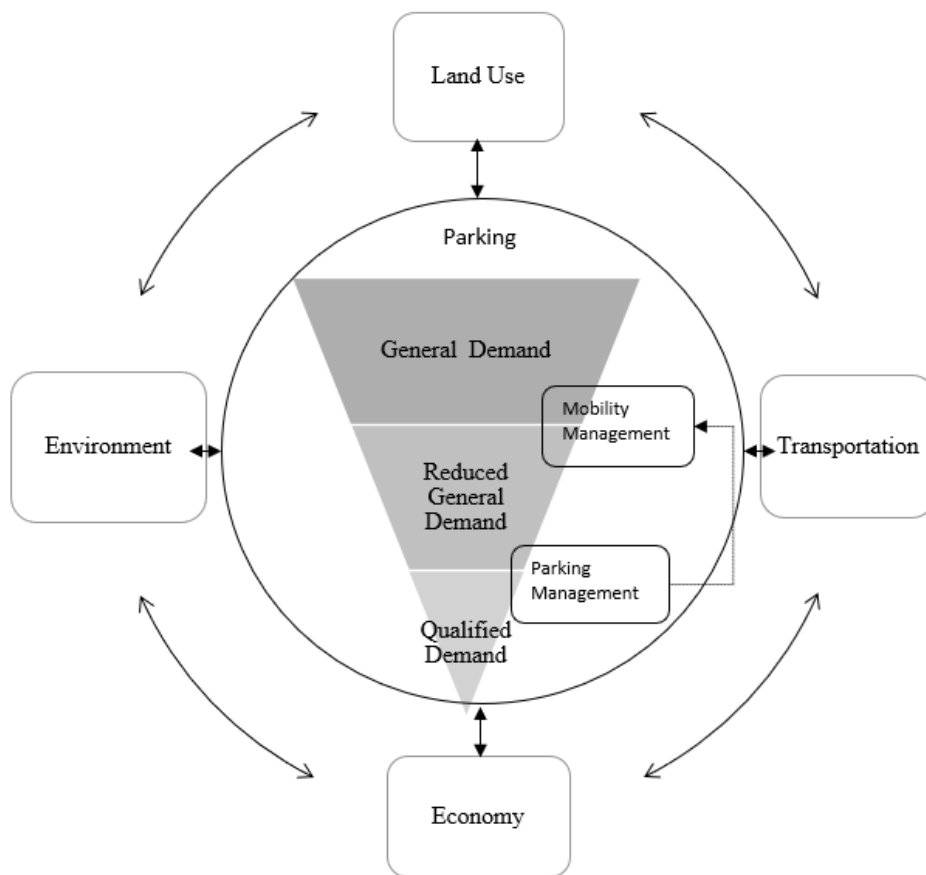


Figure 2: Paradigm of Parking Management

There has been a massive use of software using information and technologies to inform and guide users from year 2000 to the present. Every car trip comes to an end with a parking search and a parking spot. The artificial software, a novel algorithm for estimating city parking patterns based on a spatially explicit high-resolution view of the inherently heterogeneous urban parking demand and supply, is presented. Then, after analyzing the artificial software capabilities and limitations, then the software will be distributed as free spatially-based software. (Levy, 2015).

Creating a continuous-time stochastic and dynamic model for optimizing parking management of connected autonomous vehicles in the presence of multiple parking lots in a given area. The system state is considered to be time-dependent parking space availability, while the dynamic price of parking

is normally used as the control input, which can be properly chosen by parking garage operators from the admissible set. Because the stochastic dynamic model is broad and the control inputs are diversified, (Wang, 2021).

The effects of parking policies or policy packages are assessed, both on the parking subsystem and on the achievement of sustainable transportation system objectives. Exploring the extent to which high-quality public transport can support reduced car parking requirements for new residential apartment buildings. Key findings indicate that while lower demand for car parking is associated with proximity to high-quality public transport, this association is not significant when controlling for other factors that influence car ownership. (Gruyter, 2020).

Parking is spatially controlled, which means that car park supply is defined on the one hand by the geographical possibilities of the area and on the other by management criteria. Utilising data provided by the Seattle Department of Transportation and taking into account the previously stated decision-making factors, analyzing the temporal and spatial properties of curbside parking demand, and proposing methods that can improve conventional policies with simple changes by advancing understanding of where and when to apply pricing policies. (Fiez, 2019).

#### **4.1. Mobility management**

Sustainable development necessarily requires a holistic approach to problem-solving. Because parking is an integral part of the transportation system and mobility management. It can contribute to problem resolution along with parking management measures.

Park and ride, variety of work schemes, alternate solution transportation modes, government subsidies for commuters, congestion pricing, street reclaiming, accessibility strategic planning, and marketing programs are examples of these. The park-and-ride policy receives special attention because it is considered a component of the parking subsystem. The effects of these policies in addressing parking issues in central urban and highly desirable areas are highlighted in particular.

#### **4.2. Sustainable development**

Given the current level of interest in sustainable development, it is critical to begin by recalling the concept and its evolution which can also be seen in three aspects as follows:

4.2.1. Economic: A financial system must be capable of producing things and providing services on a consistent timely manner, while also maintaining an acceptable level of external debt and avoiding extreme sectoral disparities that harm agro-based production.

4.2.2. Environmental: A renewable environment, wildlife habitat, weather conditions, and other ecological processes that are not normally classified as available capital must have been included in a system.

4.2.3. Social: Equality must be achieved in the delivery of community assistance, gender, political obligation, and the participation of social groups in all aspects of life in order to be socially sustainable.

## **5 CONCLUSION**

The effects of parking management are evaluated based on trends in specific indicators over a specific time period. Following the successful implementation of a parking policy in a city, adequate communication with users is required. Information sharing with users is necessary to stimulate a positive image and raise the publics' awareness of the importance of implementation itself as a concept of quality-of-life management through mobility management. Dialogue is typically handled by the local authorities and the entity in charge of operational management or marketing. However, it is believed that cities undervalue these activities and fail to communicate effectively with service users. Various levels of correspondence are examined, and guidelines for the amount of information at each standard are made. The overall requirements for gaining a more favorable acceptance of parking policy measures are provided.

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