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ENABLING INTELLIGENT TRANSPORTATION SYSTEM (ITS) APPLICATION FOR SMART PARKING MONITORING SYSTEM (SPMS) AT URBAN ENVIRONMENT

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Abstract

Smart City conceptual development is as an approach to solve urbanization issues and improve the quality of life. Among others, the needs of Smart City are focused to enhanced the users of smart mobility. Taking action to reduce and control pollution levels is a major priority because Urban mobility accounts for 40% of all CO2 emissions of road transport and up to 70% of other pollutants from transportation record. The study was performed by reviewing and highlighting existing published studies on Intelligent Transportation System (ITS) application for smart parking monitoring system and performing gap analysis. This paper reviewed recent research towards smart parking monitoring system highlighting its implementation stage, factors and impacts

Keywords: Intelligent Transportation System (ITS), Smart City, Smart Mobility, Smart Parking Monitoring System

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INTRODUCTION

Given the rising pace of global urbanization, improving the quality of life in cities is becoming a more pressing concern for urban planners for having an efficient and sustainable urban planning system. In Malaysia context, smart city is a new idea and new mode of initiatives to promoting smart city planning, construction, management and services. The document includes the smart city definition in the context of Malaysia, seven key components of smart city, policy directions and outlines the proposed strategies and initiatives for each component that can be a reference to those interested in implementing smart city initiatives in Malaysia. In the global context, smart cities are used as one of the approached to resolve urbanization issues and improve the quality of life in the city.

Smart city is seen as a new to make Malaysia's cities more sustainable and liveable. A new strategy to urban management and development is needed. At the same time, technological advancements are taking place and the application of information technology (IT) make smart cities more feasible and convenient for people living in cities. Throughout Malaysia's development plans such as the Eleventh Malaysia Plan (11MP), the National Physical Plan 3 (NPP3) and the National Urbanization Policy (NUP2) is emphasized towards making Malaysian cities into smart cities and strengthening digital infrastructure has been embedded in Malaysia. The development of smart cities is to support Malaysia's commitment towards global agenda such as Sustainable Development Goals (SDGs) and New Urban Agenda (NUA). Cities that use ICT and technological advancement to address urban issues including to improve quality of life, promote economic growth, develop sustainable and safe environment for encourage efficient urban management practices. The components of smart city are categorized in seven components which are Smart Economy, Smart Living, Smart Environment, Smart Government, Smart Mobility, Smart Digital Infrastructure.

In short, smart mobility is a network of intelligent transportation and mobility. Smart mobility is the reimagining of the transportation infrastructure utilized in daily life and business by connecting various elements of technology and mobility. Traditional gas and electric vehicles, bike and scooter share programmers, autonomous vehicles, rail lines, and even augmented traffic realities, where road space is designated for specific modes of transportation at different times throughout the day, are all included in the definition of the smart mobility ecosystem. Smart mobility promises to bring a number of benefits for the majority of businesses across nearly every industry, efficiency being the most measurable. Increasing efficiency with smart mobility services would not only have a positive impact on the economy. The environmental impact of a massive decrease in CO₂ emissions and resulting pollution would positively improve the quality of life for the urban population. The issues pertaining to CO₂ emissions is very much related to transportation. Parking spaces are found to be more than

plenty in some places and very hard to find in others. This difficulty in finding parking spaces may lead to more time consuming besides cost and CO₂ emissions. The main aims of this paper is to review the existing Intelligent Transportation System (ITS) used to support Smart Parking Monitoring Systems (SPMS) and identifying the gap of its implementation. The motivation of this paper is to propose the mandatory installation of ITS application at every parking space under the local authority applying for 'Planning permits' from Local authority.

SMART CITIES

Smart Cities were defined by the British Standards Institute as the effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens (Filipe, 2019). In addition, a smart city also can be defined as an urban area which encompassing possibly different areas and scales of the city that includes street, plaza, neighbourhood and the entire city. The smart cities use electronic data collection sensors which located on infrastructures, buildings, vehicles, institutions and devices which known as Internet of Things (IoT) to supply real time information of the main cities operating system. Since most smart city related to the projects have risen from the bottom-up experiences related to the specific problem it will become difficult to have a generalizable definition.

According to Byod (2014), the smartest cities in the world has emerged as a key mechanism for cities to find innovative solutions to the challenges they face. Increased demand for infrastructure, housing, transportation, jobs, energy, food, and water are all straining city governments and infrastructure as people from all over the world flock to cities in search of a better life and more opportunities. However, in recent years, cities have begun to think more holistically about what it means to be a smart city, and have innovated new ways to modernize how a city serves its citizens. Smart cities are a complex phenomenon and any effort to measure them needs to contain breadth and depth of indicators. Other than that, the smart city is a concept, and there is no clear and consistent definition of it between academics and practitioners. In addition, a smart city is a location where traditional networks and services are made more flexible, efficient, and sustainable through the use of information and digital technologies with telecommunications technologies. In other words, in a smart city, digital technologies translate into improved public services for residents and businesses. In other hand, the smart city is a city connecting the physical infrastructure which includes the information technology infrastructure, the social infrastructure and the business infrastructure to leverage the collective intelligence of the city. A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve

quality of life, efficiency of urban operations and services, and competitiveness, while also meeting the economic, social, and environmental needs of current and future generations. Smart city includes the components to be labelled as smart component. These elements are what enable cities to be smart and efficient. ICT (information and communication technology) are key enablers in the transformation of traditional cities to smart cities. The Internet of Things (IoT) and Big Data (BD), two closely related emerging technology frameworks, make smart cities efficient and responsive. The technology has sufficiently matured to allow smart cities to emerge. However, there is a great need for physical infrastructure, renewable energy, ICT, IoT, and BD to make the majority of cities around the world smart. A smart city is an urban area using information and communication technologies, business models and solutions for increasing operational efficiency, sharing information with the public, and improving both service quality and citizen satisfaction welfare. One of the key pillars of the Smart City concept is Smart Mobility. Using various technological solutions in all areas of transportation and traffic science, the possibilities for incorporating technology into the transportation sector are expanding increasingly. The advancement of information and communication technologies is taking place key elements in the creation of a Smart City Mobility in cities has become one of the most important issues the most serious issues confronting local governments. Related to this component, there are many different definitions that are the growing number of private cars, road accidents, congested roads in the traffic network, less public space for people, and economic stagnation force local governments to develop sustainable and environmentally acceptable urban mobility solutions. Smart Mobility is a concept in which travel time is optimized using various past and real-time data and the assistance of information and communication technologies, resulting in reduced space usage, road congestion, road accidents, and harmful gas emissions. According to Nagy (2020), smart mobility is being separated into two segments which are (1) innovative solutions and (2) development of current services. In order to consider that the mobility system of a city is smart, it is necessary that the smart mobility system is operating and self-correcting by requiring little or no human intervention. In terms of smart mobility, the main aspect of smart mobility is connectivity which including the big and open data. Road users can transmit all the information in real time, and public administrators can simultaneously conduct dynamic management which the preparation of data will including the data on available of parking spaces, traffic conditions, accidents, trains and bus delays. In these two terms, the open data and big data is not the same. The big data is a dataset usually difficult to process with traditional database and software techniques; for example, the data generated by millions of trips and logged on a daily basis by electronic transit cards and “open data” is data.

The SMART principle which known as smart, measurable, achievable, relevant and timebound helps to determine the optimal set of indicators for assessing the level of quality in transport systems. To sustain the urban mobility process, smart mobility indicators must be set. The concept of smart mobility widely used is focused on citizen needs, quality of life and health in the city, during the planning and implementation phases. The chosen measures, serving as guidelines for achieving the sustainable goals, should be measurable by indicators. The indicators are based on measuring the rate of implementing information and communication. The concept of smart cities practically focuses on urban transformation, based on sustainability.

However, because every society has economic, social, environmental, and institutional dimensions, smart cities and sustainability must incorporate these elements as well. In addition to the aforementioned trends, ICT applications and information or knowledge-based societies emerge. Globalization, re-urbanization, and changes in social mobility behavior pose significant challenges to transportation technologies. There are two segments for smart mobility concept which known as (1) innovative solutions and (2) development of current services. Innovative solutions are not present in every urban transportation system, however according to Simon (2020), innovative solutions are not present in every urban transportation system. The innovative solutions play a main role in smart mobility-oriented development. In smart mobility, the autonomous vehicles (AV) and electric vehicles are tools on the vehicle side. Mobility as a Service (MaaS) is a new concept. Shared mobility solutions are effective tools to increase the efficiency of cars. ICT applications that include hardware and software demand driven solutions are spreading. Parking services are also moving to automated solutions.

Hence in Malaysia, to realize the objective of smart mobility, there is a crucial need to improve on accessibility to public transportation, integrated mobility, management of traffic and technologies for parking. These will then become a turning point in the government's initiative towards becoming a Smart City. But then most Malaysians prefer to drive their own cars, adding to traffic congestion problems. Therefore, the government needs to discourage the usage of cars while upgrading our public transportation system to encourage people to make the right choice. Based on the literature study, indicators of smart mobility are as follow:

Table 1: Indicators of smart mobility based on literature

Variables	Indicators	Concept
Location Efficiency	Support for Sustainable Growth	Transportation plan that supports for Sustainable Growth
	Transit Mode Share	Level of intermodal transportation usage
	Accessibility and Connectivity	Accessibility and connectivity of transportation mode
Reliable Mobility	Multi Modal Travel Mobility	Efficiency of time and cost on transportation
	Multi Modal Travel Reliability	Time predictability
	Multi Modal Service Quality	User's satisfaction by convenience transportation
Health and Safety	Multi Modal Safety	Safety on Transportation
	Design and Speed Suitability	Suitable Facilities
	Pedestrian and Bicycle Mode Share	Level of Pedestrian and Bicycle Users
Environmental Stewardship	Climate and Energy Conservations	Level of Vehicle Usage
	Emission Reduction	Emission level generated from vehicles
Social Equity	Equitable Distribution of Impacts	Adequate facilities for all social groups
	Equitable Distribution of Access and Mobility	Adequate cost and time on transportation for all

Source: Indrawati (2017)

Smart mobility aims to improve everyone's daily life. The advantages for implement smart mobility in the city will improve the motorist's experience which the road users, whether in their own vehicles or on public transit, have real-time information that gives them the opportunity to make mobility choices based on events. They can also make the most of the time they spend in transportation by planning their itinerary before leaving. Other than that, the Intelligent mobility makes public transportation more accessible, more reliable, and more attractive. The various tools enable users, for example, to pay contactless, simply and quickly, or to locate their bus/tram and find out how far away they are from the stop. They also make it possible to improve traffic flow, optimize network and fleet management and reduce disruptions due to service interruptions.

Smart mobility helps reduce congestion and pollution, for example by offering alternative routes in the event of an accident, thus avoiding traffic jams that cause pollution peaks.

FACTORS ON INFLUENCING PARKING ISSUES

Intelligent Transportation System (ITS) for Smart Parking Systems

Luis (2019), noticing that the global smart parking system market size is expected to reach USD 368.7 million by 2024. Smart parking systems are considered ITS solutions that enable effective traffic congestion and parking-related issues to be addressed. Such systems aid in reducing fuel consumption and, as a result, vehicular emissions. The increase in the number of automotive and the lack of an efficient. The increasing number of automotive and the lack of an efficient parking management system is affecting the availability of parking spaces and is subsequently driving the demand for these technologies across the globe. Smart parking development implies an IoT based system that sends data about free and occupied parking places via web/mobile application. The IoT-device, including sensors and microcontrollers, is located in each parking place. The user receives a live update about the availability of all parking places and chooses the best one. The creation of smart parking using the Internet of Things and ultrasonic sensors where available parking places could be displayed in a dashboard or any web application in Malaysia. Smart parking also is a strategy that combine technology and human innovation in an effort to use as few resources as possible such as fuel, time and space to achieve faster, easier and denser parking of vehicles for the majority of time they remain idle. Parking is divided into two categories which known as:

On -Street Parking

On-street parking means parking the vehicle on the street, anywhere on or along the curb of streets, in contrast to parking it in a parking garage. In some streets, this type of parking can always park your vehicle on the street, but sometimes there are restrictions. Mostly these restrictions are presented on traffic signs.

Off -Street Parking

Off-street parking means parking your vehicle anywhere but on the streets. These are usually parking facilities like garages and lots. Off-street parking can be both indoors and outdoors. Off-street parking also includes private lots, garages and driveways.

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Smart parking refers to the use of sensing devices to determine occupancy at the space level or at the lot/structure level. Car parking problems are a major contributor. Searching for a parking space is a routine activity for many people in cities around the world. This search burns about one million barrels of the world's oil every day. Based on previous study, more than half of drivers among 8000 commuters in twenty cities worldwide said during the past year they gave up at least once when looking for a parking space. When the driver rapidly finds a parking area by minimizes the on-street parking, it helps to regulate public transportation and generates revenue for developing smart cities. The connectivity in a major challenge in developing cities. IoT based free parking space shows accessibility with the android-based application.

The current model of parking management requires a manual mechanism, to guide the free parking area as well as record the number plate and the time of every vehicle. The manual methodology takes a lot of time to record the vehicle information like the number and entry-exit time. With the existence of internet of things (IoT) devices, regular advertising the free slot and occupied slot to a centralized location where the driver or concerned person can easily access the information about their vehicle. An automated method to record the vehicle information and guide for the free slot save time. Vehicle information likes entry-exit time and real-time situation including the threats and stored into the cloud timely which this will access by the authorized person. Vemula (2014), creates a model that shows how smart parking management system connected to this study.

For above model, the presented automated parking management model does not require any manual intervention. Integration of cameras and sensors simplifies the complexity. A free area of land meant for parking purpose have 100 number of parking slot available, out of which 75 for 4-wheeler and 25 for 2 wheelers. Each slot has allocated a unique number. There are two lanes, one is for entry and the other one is for an exit. A camera and infrared (IR) sensor are connected to each gate which controls the activity of the turnstile gate. When a vehicle comes near the turnstile gate to enter, the IR sensor at the entry of the gate detects the vehicle. Whenever a vehicle has detected the camera (CCTV/webcam) captures the image of the number plate and saves it on the local disk of the mainframe system. Smart parking suggests an IoT-based system that sends data to free and busy parking places via net and mobile applications. The IoT-network

includes sensors and microcontrollers, which are found in each parking place. We implemented an enclosed smart parking project (SPMS), that using the Internet of Things and IR sensors, where available parking places can be displayed in a web application, then the user receives a live update about the availability of all parking places and chooses the best one. Smart parking IoT implementation is usually divided into the following parts.

Table 2. Smart Parking System

Collection	The collection depends on parking sensors to collect real-time parking. The parking systems may use sensors like Infrared, and Ultrasonic Sensors detect whether a parking spot is empty or not
Processing	The processing unit acts as interference between the sensors and the cloud. It includes an Arduino which is a processor on-chip. All the sensors are wirelessly connected to the processing unit, and data collected from various sensors are sent to it through the esp8266 chip.
Deployment	It deals with communication methods. Message Queue Telemetry Transport Protocol (MQTT) is a publish-subscribe based messaging protocol that is used on top of the TCP/IP protocol
Services	It can be made available to users once they finish storing data and monitoring information
Connection	Interested in the Internet of Things layer that deals with the database of parked cars through a shared server. The cloud stores data for available parking lots, user sites, profiles.
Mobile Application	It is the interface application between humans and the system

Source: Amira A (2020)

Intelligent Transportation System for Smart Parking Monitoring System: Review in Malaysia

In Malaysia, some of the areas you still can park free without need to pay anything. Due to not fully implement the parking meters from the government or the parking meters always malfunction, and lack of the officer manpower to raise the compound tickets to the car parking users. But this is going to end very soon. Malaysia's city council have launched the Smart Parking Systems or Apps in order to increase the car parking collection and reduce the operating cost. The

using of LPR Smart Parking is the one of technology that moving rapidly which using the LPR Technology that can be ticketless when enter the parking area. With the IOT revolution in the smart parking system in Malaysia, not only makes the lives easier to the car park user like you and me but reduce the operating cost of the car park operator, business owners, and building owners tremendously. This might not really realize now, but very soon in coming near few years, 70%–80% of the car park in Malaysia is covered using IOT smart parking and wherever you go, no more seeing the ticket/card machine. The implementation of smart parking monitoring system is a system that indicate the available parking spaces for the car owners. The management of the parking system has been improved for searching the available car parking spaces. The smart parking monitoring systems will indicate the available car park spaces using a monitor at the entry point of the car park. In Malaysia, the uses image processing and CCTVs to detect the car movement in the parking system. This research uses image processing and CCTVs to detect the car movement in the parking system via the car registration number. The implementation of ITS regarding to smart parking monitoring system includes:

Image Detection System

In Malaysia, many of image detection systems have been implemented and its restriction has offered. these restrictions are sometimes overcome through expensive and complex systems. The need on this research is a versatile (licenses plate recognition) LPR system that yields good results running on a low-cost platform in a controlled environment. Based on some principles of neural networks, that is fast enough to be applicable in camera in motion, the system embed the use of plate recognition in, with the specific parking ticket the system will be optimum.



Figure 6: Image Detection System
Source: Thinxtra (2021)

CCTV (Closed Circuit Television) is a visual surveillance technology designed for monitoring a variety of environments and activities. CCTV systems typically involve a fixed (or "dedicated") communications link between cameras and monitors, in our work CCTV involve as shown in the flow chart somehow it will make the system complement by adding level of management on the parking system. The CCTV'S in this system will be distributed as two CCTV in each area.



Figure 7: CCTVs System
Source: Thinxtra (2021)

CONCLUSION

Smart Parking is currently the most popular Smart City initiative. Several Smart Parking projects have been launched in many cities around the world to alleviate traffic and parking issues. Smart Parking is regarded as a low-barrier solution due to its ease of installation, scalability, efficiency, and flexibility. It is ideal for modern cities looking to provide potential benefits to their citizens while leveraging the power of IoT. Advanced and intelligent parking solutions not only reduce traffic on the roads, but also keep drivers from becoming stranded in areas where parking is unavailable. Drivers can easily find available parking spaces by using real-time data displayed on digital displays or mobile applications. These innovative solutions are perfect for resolving the parking problems in urban areas. The smart parking solution provides a stress-free parking experience to the drivers and enables them to find vacant parking spaces immediately around their destination.

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