

DOI: 10.21625/archive.v3i2.515

Smart Parking as One of the Smart Cities Mechanisms**(Case study: the Central Business District in the city of Cairo).****Walid Fouad¹***¹General Organization for Physical Planning (GOPP), Cairo, Egypt***Abstract**

The study aims at determining the importance of smart parking as one of the basic applications of smart cities; to solve the urgent problems of central business district in the capital cities in the Middle East, which suffer from many problems in traffic and thus negatively effects on quality of life.

The study deals with central business district in the city of Cairo, which suffers from serious traffic problems, as a result of the steady increase in demand for parking, especially with the rapid population growth and the absence of places for future expansions .

The importance of the study is to develop planning solutions to solve the issue of the paucity of parking area and the problems resulting from them, through intelligent techniques that ensure minimizing the problem and achieve sustainable development .

The methodology of the study was based on an analysis of the problem of lack of parking spaces in central business district in Cairo city, its causes, negative results on traffic and quality of life, and analysis of previous studies that dealt with this problem through traditional methods. and the determinants facing the decision maker planning, and ends the study to develop a comprehensive plan for the smart parking of the Central Business District in the city of Cairo as an example.

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Keywords

Smart Cities; Smart Parking; Smart Transportation; Quality of life; Cairo CBD; Sustainable Development.

1. Introduction

For cars; parking times are more than walking times. Parking on the both sides of the road or in non-designated areas leads to accidents and traffic jams. To ensure that the above problems are minimized, it is necessary to create parking spaces according to the appropriate planning and design Standards.

As a result of the growth of cities, especially the capitals, and with the increase in the volume of activities in the centers of the central business districts, the scarcity of available land to add new parking spaces, and with the increase in ownership of cars; the multi-floors parking become not enough to bear this increase, so it need smart and unconventional solutions to this problem.

Smart cities are considered one of the most important solutions especially for large cities. With regard to parking areas, the smart parking is one of the smart cities concepts mechanisms that increase the absorption of cars

with intelligent technology that preserves the environment, achieves sustainable development, and increases the competitiveness of the city.

Cairo is one of the largest capitals in the Middle East. The central business district suffers from this problem. Therefore, we try in this paper to find the planning solutions to apply the concept of smart attitudes to the status of Cairo as a model for similar cases in order to achieve improvement of the living level of the population and sustainable development.

2. Methodological Framework:

The methodological framework of the research consists of: problematic, hypothesis, objective and methodology.

2.1. Problematic:

An increase in car ownership leads to an increase in the demand for parking spaces in the city centers, with the scarcity of land and high prices, resulting in daily suffering for the recipients of the service.

2.2. Hypothesis:

The non-traditional solution, such as smart car parking, compensates for the scarcity of land in business centers in capitals and contributes to the sustainability of development and the improvement of quality of life.

2.3. The main objective:

Assisting the decision maker in finding sustainable and non-traditional solutions to reduce the traffic problems resulting from the increasing need for parking, especially in the central business district of the capitals.

2.4. Methodology:

The intellectual approach to research consists of three basic frameworks, first (the induction framework) related to the monitoring phase, the second (analytical framework) related to the understanding stage, and finally (the applied framework) associated with the application phase.

3. Theoretical framework:

The theoretical framework includes the different systems of smart parking, and the concept and features of each systems, to find out the adequacy of each system for the case study in Cairo center.

Definition of smart parking: The Smart Parking service, a part of Intelligent Transportation System (ITS), gives rise to different parking facilities on the basis of new functions they provide. This service not only manages the internal operations of the parking facility, but it is also designed to work with different aspects related to the parking facility. (Faheem, 2013).

3.1. Smart parking systems

Smart parking is classified into five systems (Adeeb, 2016), which we will explained substantially, to show what they are, their features, and the implications, as follows:-

3.1.1. **Parking guidance and information system:**

The main components of the Parking Guidance Information (PGI) system are Vehicle Detection Processors (VDPs) and Variable Message Signs (VMS). In addition, each car park will be equipped with a central processor which controls each PGI system.

VDPs are installed at vehicle entry and exit points within a defined area or zone to perform the vehicle counting function. These patented innovative VDPs have been designed to provide a highly accurate vehicle monitoring solution, allowing the operator to reliably display space availability and guidance information to users of their car parks. As a result of the high degree of accuracy, customers of the car parks will place confidence in the information provided and, consequently, will heavily influence their parking behavior. Customers who have satisfactory experiences of car parks that provide reliable guidance information will be more likely to use these facilities on a regular basis. It will enhance their overall usage experience of not only the car parking facilities, but also their experience of the adjacent facilities (e.g. shopping Centre, restaurants, hotels, etc.).

The e-Park system is designed to provide effective PGI solutions to individual car parks as well as offering the possibility of linking a large number of car parks together, as illustrated in Figures1-4, and the Results of PGI system and the positive effects, as illustrated in table 1.

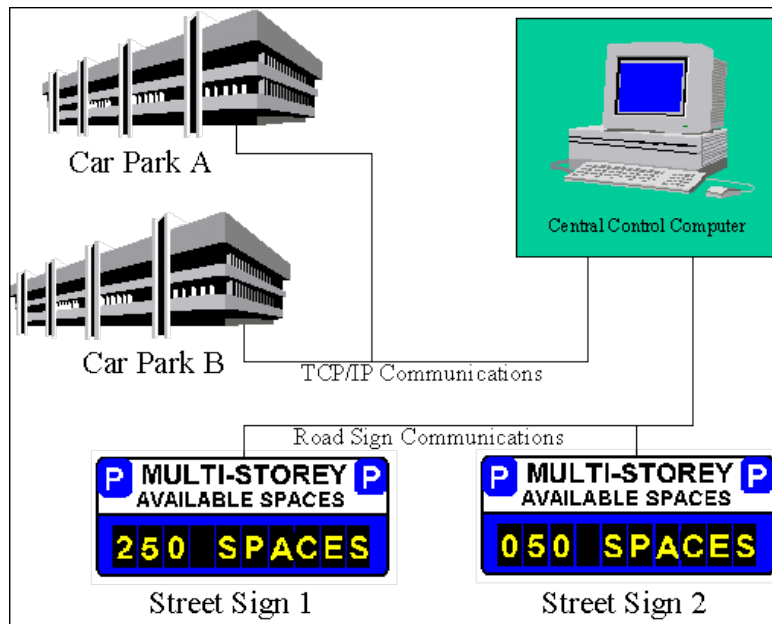


Figure 1. Overview of e-Park System (Tripod, 2018).

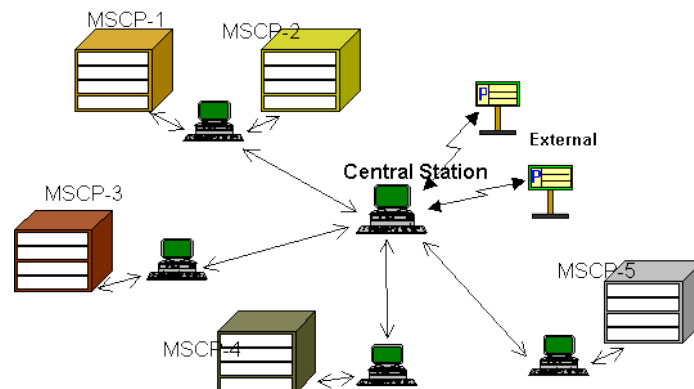


Figure 2. Architecture of e-Park solution linking a group of Parks.(Tripod, 2018).

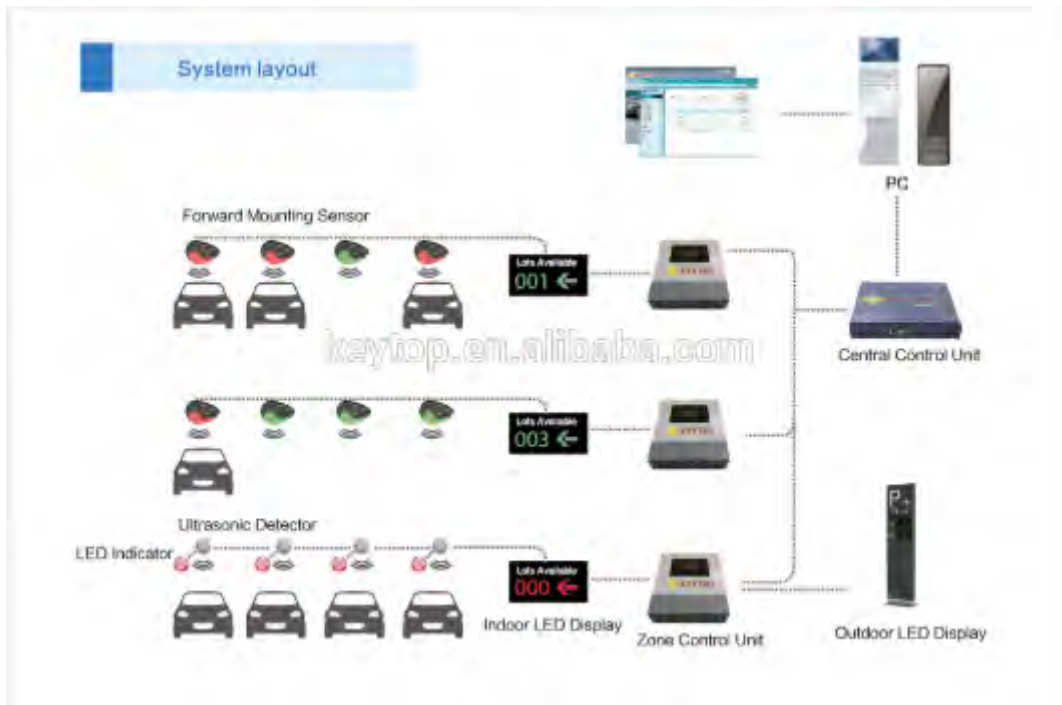


Figure 3. A Parking Guidance System layout (Keytop, 2018)



Figure 4. A Parking Guidance System in Singapore (for example). (Harman, 2009)

Table 1. Results of PGIS system, the positive effects (Adeeb, 2016)

Direct results.	Improving the management of the attitudes and quality of service.	<ul style="list-style-type: none"> • Easy to get empty parking. • Maximize efficiency and increase operational efficiency.
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Table 1 continued

Positive effects (indirect)	Save time and effort.	Avoid parking fully encumbered positions and identify the empty place easily
	Improve the flow of traffic.	<ul style="list-style-type: none"> • Reduce the number of cars parked illegally on both sides of the road by absorbing them inside the parking. • Reduce traffic associated with search for empty parking.
	Increase economic profits.	<ul style="list-style-type: none"> • Increasing productivity of individuals as a result of not being delayed from work. • Reduce fuel losses. • Increased parking income due to optimal utilization.
	The reduction of environmental damage and health.	Reduce the amount of emissions from cars and thus reduce the rates of environmental pollution and noise.

3.1.2. Transit-based information system

It is a parking management technique, a parking system that resembles a parking guidance and information system, but directs the driver to Park and Ride lots.

Park and Ride are parking lots connected to public transport stations located in or near the city, for cheap or no costs. The aim is to leave cars away from the city center, and to travel by public transport (bus, railway, metro...).

To facilitate Park and Ride, Parking guidance and information are used to determine available parking which management by Park and Ride system. As illustrated in Figures 6, 7, and the Results of Park and Ride system and the positive effects, as illustrated in table 2.

Table 2. Results of Park and Ride system and the positive effects. (Adeeb, 2016).

direct results	Reduce the rate of use of the car.	<ul style="list-style-type: none"> • Providing parking spaces at the transport station. • Improving the level of public transport service and increasing the rates of use.
The positive effects (indirect)	Improving the management of the attitudes and service quality.	<ul style="list-style-type: none"> • Easy to get empty parking. • Maximize efficiency and increase operational efficiency.
	Save time and effort.	<ul style="list-style-type: none"> • Reducing the search for parking in the city centers.
	Improve the flow of traffic.	<ul style="list-style-type: none"> • Reduce the number of cars parked illegally on both sides of the road by absorbing them inside the parking. • Reduce the traffic associated with the search for empty parking.
	Increase economic profits.	<ul style="list-style-type: none"> • Increasing productivity of individuals as a result of not being delayed from work. • Reduce fuel losses. • Increased parking income due to optimal utilization
	The reduction of environmental damage and health.	<ul style="list-style-type: none"> • Reduce the amount of emissions from cars and thus reduce the rates of environmental pollution and noise.

3.1.3. Smart payment system

A technique for managing the payment of parking fees, which uses electronic payment techniques (EPSs) to pay fees, to overcome the disadvantages of cash payment methods. (Adeeb, 2016).



Figure 5. Sign for a park and ride site in a UK town. (UK Construction,2016).



Figure 6. Colchester Park and Ride (Pick Everard,2018).

In addition to automated fee collection systems, various alternative advanced payment systems have started to appear. Some of the most commonly used systems include: (François and others, 2011).

- **Smart card systems:** These systems allow drivers to electronically load money into a card with an integrated circuit chip and then have the money debited with each use of the card. Smart card technology is highly secure and relatively inexpensive.
- **Pay-by-phone systems:** These systems use automated answering machines or short messaging services (SMS) to allow prepayment of parking. Drivers use their mobile phones to wirelessly deposit money towards time in a parking space, and most systems can give users updates about remaining or expired time via SMS messages.
- **RFID tags:** have long been used to support highway toll operations. Similar tags can be used to automatically charge vehicles entering a parking facility. Upon parking, a driver simply has to turn on an in-vehicle device that would communicate with the parking management system and debit the parking fee from the user's account.
- **In-vehicle meters:** Such systems are typically an extension of smart card or pay-by-phone systems. When drivers pull into a parking spot an in-vehicle meter communicates wirelessly with a centralized management system. Since different meters can be installed in different vehicles, this technology easily allows for price discrimination.
- **E-Parking systems:** E-parking is an advanced parking management concept for off-street parking that brings together parking reservation and payment systems. E-parking systems rely on an electronic parking brokerage for parking providers. Drivers use their cellular phones, PDAs, or the internet to access a portal website where they can view available spaces and prices and subsequently reserve a space.

Illustrated in Figures 7, 8, and the Results of Park and Ride system and the positive effects, as illustrated in table 3.



Figure 7. Advanced payment systems for managing the payment of parking fees (Smith,2012).



Figure 8. One of the new smart meters in Bethesda. (Lannelli,2015).

Table 3. Results of Smart payment systems and the positive effects (Adeeb, 2016).

Direct results.	Improving the management of the attitudes and quality of service.	Reduce the time of entry and exit.
The positive effects (indirect).	Save time and effort.	Reduce traditional procedures for entry and payment. Reduce the search for free parking spaces. Reduce fully booked parking.
	Improve the flow of traffic.	Reduce the number of cars parked on both sides of the road. Reduce the traffic associated with the search for the empty parking space. Reduce congestion in front of entry and exit from the park.
	Increase economic profits.	Increasing productivity of individuals. - Reduce fuel losses. Increased parking income due to optimal utilization.
	The reduction of environmental damage and health.	Reduce the amount of emissions from cars and thus reduce the rates of environmental pollution and noise.

3.1.4. **E-parking (electronic parking) system**

A parking management technology that acts as a parking inter mediation service, an interactive online marketplace that allows for parking reservation and payment of fees with smart systems and is based on the principle of electronic commerce. (Adeeb, 2016). The system works through:) Thomas and Other, 2004).

The parking space provider offers parking space available for reservation. This information is registered in the PSOS database.

Users are able to access the PSOS via Internet or WAP for obtaining parking information or for making a reservation request. The reservation request is registered in the PSOS database.

The PSOS sends the booking information and access code to the end user subject to the acceptance of the reservation request by the Parking Space Provider.

The car enters and exits the parking facilities using Bluetooth to open the barrier.

Once the car exits the car park electronic payments is made and the whole operation is registered in the PSOS.

As illustrated in Figures 9 : E-parking System functionality, and the Results of E-parking System and the positive effects, as illustrated in table 4.

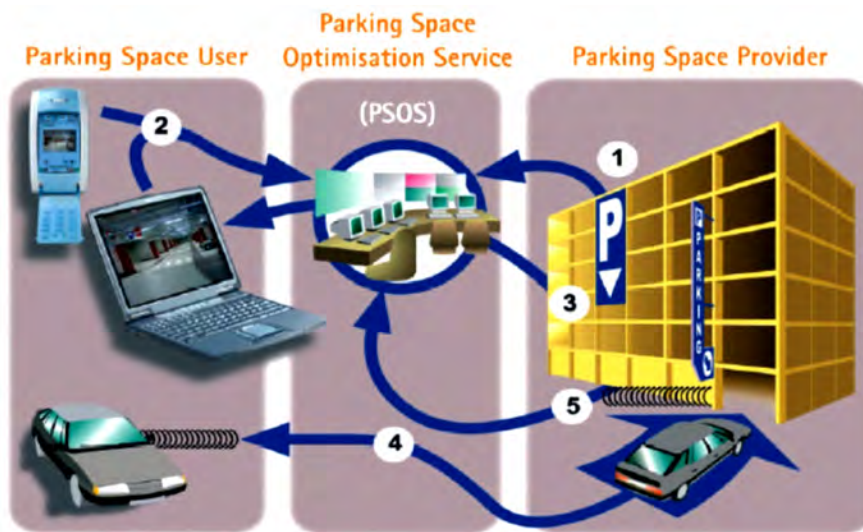


Figure 9. E-parking System functionality. (Adeeb, 2016).

Table 4. Results of E-parking system and the positive effects. (Adeeb, 2016).

Direct results.	Reduce the rate of use of the car.	Reduce the time of entry and exit using electronic payment systems. Increase the operational efficiency of the facility.
The positive effects (indirect).	Improving the management of the attitudes and service quality.	Avoid parking fully encumbered positions and identify the empty place easily.
	Save time and effort.	Reduce the number of cars parked illegally on both sides of the road by absorbing them inside the parking. Reduce the traffic associated with the search for the empty parking.
	Increase economic profits.	Increasing productivity of individuals as a result of not being delayed from work. Reduce fuel losses. Increased parking income due to optimal utilization.

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Table 4 continued

	The reduction of environmental damage and health.	Reduce the amount of emissions from cars and thus reduce the rates of environmental pollution and noise.
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3.1.5. Automated parking system

Automatic parking system (APS) was developed in order to reduce the area designated for parking cars. Similarly, as in the case of multi-level car parks, so in the case of APS, the approach taken is to park vehicles in multi-level vertical stacks in such a way as to limit the use of the land designated for car park while ensuring the maximum number of parking spaces. In the literature. (Słezok, 2015).

Automatic parking is based on the unit system, which is the basic design standard. The cars are parked in these units vertically and above the other on multiple levels. These vertical units are assembled and installed together in a variety of flexible and varied ways, and how they deal with the surface of the land, some of which are built on the top of the land or the bottom of the surface of the land or a mixed structure in order to ensure optimal work for parking places (Adeeb, 2016). Figure 10, 11, 12.



Figure 10. (APS) surface of the land. (Shanghai Shi Wen, 2018).



Figure 11. (APS) under the land. (PerfectPark, 2018)

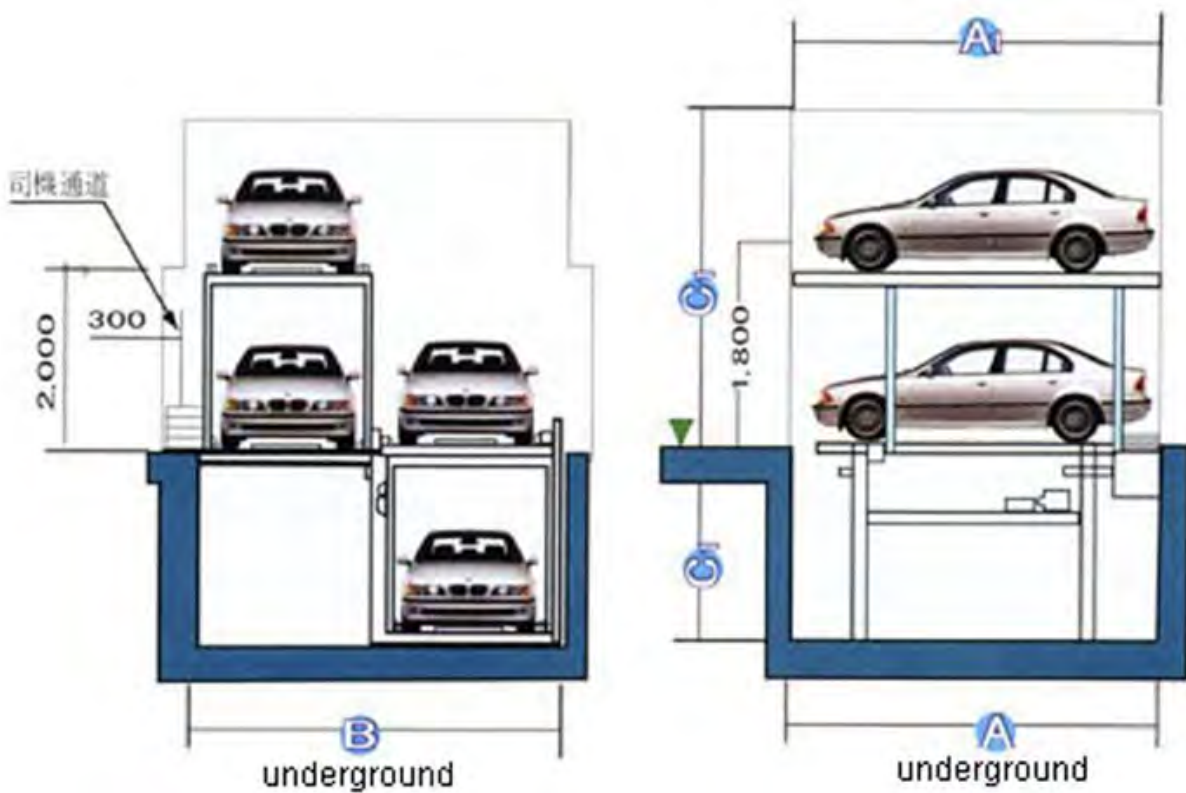


Figure 12. (APS) top & under the land. (STMI, 2018)

Automatic parking systems are uniquely space efficient. The cars are stacked into snug compartments using a robotic arm, platforms or lift systems and due to the absence of passengers the parking space doesn't have to be as wide as in a conventional parking lot. There's no need for ramps, pedestrian footpaths, staircases or walkways (Lies, 2018).

APS has come a long way since then, and the terminology used to describe such systems includes: "Mechanical

Parking System, Robotic Parking System, Rotary Parking System, Automatic Parking, and Stacked Parking” (Lies, 2018).

Table 5. Results of Automated parking system and the positive effects. (Adeeb, 2016).

Direct results.	Improving the management of the attitudes and service quality.	Advantage of the horizontal space of the facility. Take advantage of vertical space rather than limited horizontal space. Exploitation of the vacuum inside the earth. Easy to get empty parking. Maximize efficiency and increase operational efficiency.
The positive effects (indirect).	Save time and effort.	Reduce the traffic associated with the search for the empty parking.
	Improve the flow of traffic.	Reduce the number of cars parked illegally on both sides of the road by absorbing them inside the parking. Reduce the traffic associated with the search for the empty parking.
	Increase economic profits.	Increase the productivity of individuals as a result of their delay. Fuel consumption reduction. Increased parking income. Low labor costs necessary to operate and control the place. Energy saving (requires no internal ventilation). Exploitation of advertising interfaces (source of income).
	The reduction of environmental damage and health.	Reduce the amount of emissions from cars and thus reduce the rates of environmental pollution and noise.

4. Practical Framework

4.1. Successful experience in smart car parking (Dubai experience)

The study of smart parking systems in Dubai is an example of the Middle East countries to measure the extent of the movement completed in the case of Egypt. In UAE, Local transport authorities govern public parking areas in respective emirates. Parking fees differ in each emirate depending on the location, type and duration of parking. Parking is free on Fridays and public holidays. People with special needs are entitled to park free of charge.

4.1.1. Smart Payment Systems For smart parking in Dubai

There are five smart payment systems to take advantage of the parking lot service in Dubai, as shown in table no 6.

Table 6. Smart Payment Systems For smart parking in Dubai. (RTA, 2018).

P. Smart System.	Explanation of the system
Payment in cash.	Pay the devices allocated and distributed throughout the positions, placing currencies in the category of dirham and half dirhams for the time required to use the position and the class position, and then put the ticket on the front of the car from the inside in a visible place.

Continued on next page

Table 6 continued

Payment by Nol” Card.	”NOL” cards are used to pay in the allocated devices and distributed throughout the parking space, in exchange for the time required to use the position, to the device to deduct the value due from the balance of the card, and then put the ticket on the front of the car from the inside in a visible place.
Prepaid Card Payment.	With prepaid parking cards, customers can pay parking fees without having to carry cash. Payment for parking services is done by inserting the card into the payment devices that charge the fees for the number of service hours.
M. Parking SMS.	”M. Parking SMS” service by sending a text message in a specific format, after which the user will receive confirmation of the success of the debit payment from the phone balance, as well as alert messages as the time limit in the positions approaches, 10 minutes before the end of the specified time.
Smart Phone Application.	The RTA Dubai application” for smart mobile phones provides an easy and fast way to access a number of RTA services in Dubai, including parking services, which are deducted from the phone balance.

4.1.2. Smart Zone of DMCC in Dubai

In line with the DMCC Smart Zone strategy and the ongoing efforts to enhance the experience and comfort of the Jumeirah Lakes Towers community, we have collaborated with the RTA in Dubai to provide smart parking for short-term visitors at the upper and public levels, as in figure no 13.



Figure 13. Jumeirah Lakes Towers Smart Parking. (DMCC, 2018).

Drivers will be allowed to pay parking fees through the m-Parking system of the Authority via SMS easily and easily, or through the application of intelligent smart parking dedicated to this end.

Comment: The experience of Dubai can be used in smart parking in Egypt, but it requires the development of infrastructure, and encourage domestic investment in this field.

4.2. Case study overview

In this part of the research, we will try to deal with the study situation (Central Business District in Cairo) and take advantage of the smart parking systems, which were studied in the previous point (2), to develop the parking system in central Cairo in preparation for circulation to all over the city. The practical framework is addressed in two main points: Indicators of the current conditions of parking in central zone, Recommendations for the development of smart parking systems in the business center in Cairo.

Downtown Cairo was developed by Khedive Ismail in 1869 to showcase a modern Cairo as “the symbol and showpiece of Egypt’s progress”. The downtown was designed with a radial network of straight, wide streets connected by squares, and public green spaces, all which contrast with the complicated network of narrow streets in the urban design of Islamic Cairo (Awatta, 2015).

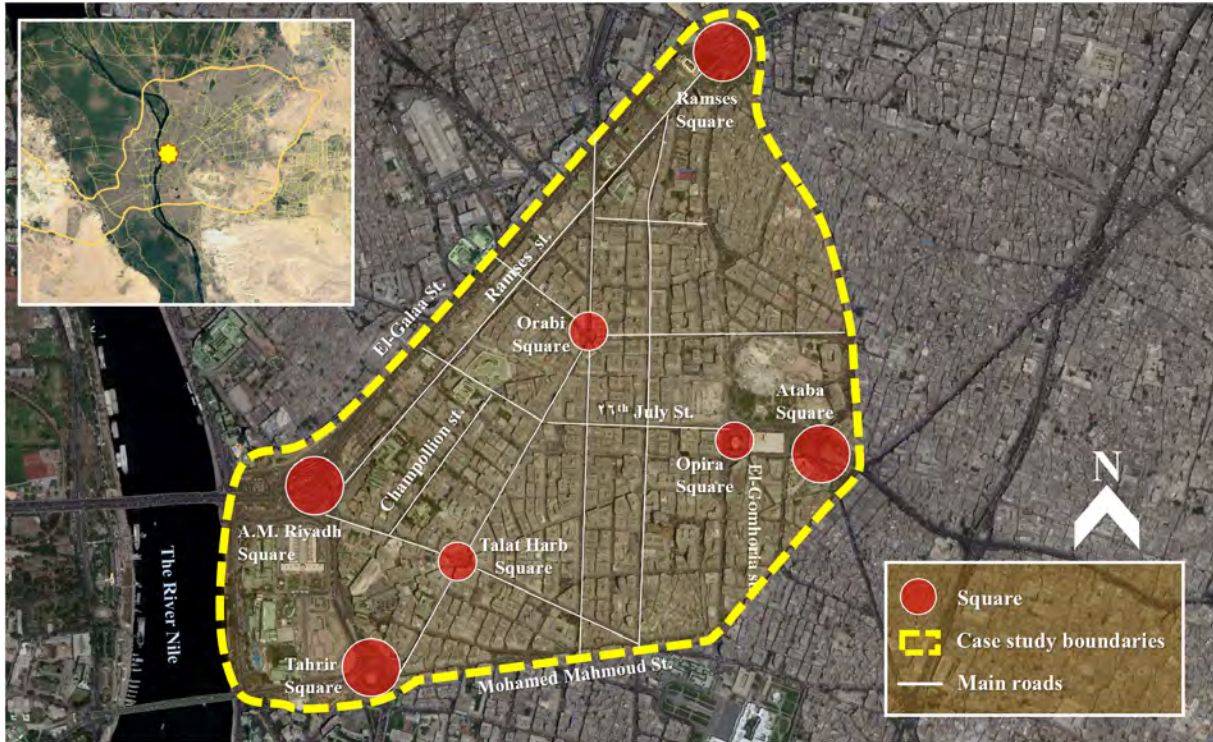


Figure 14. Case study boundaries. (Researcher, 2018).

The CBD connects north Cairo (Nasser City) with west and south districts as Giza and Maadi. The case study boundaries are shown in enclosed between Ramsis street, Mohamed Mahmud Street, El Gomhoria and Nagib El Rehani street. That area includes main and local streets. A transformation in the identity of downtown started in 1950, from an elite and exclusive space into a commercial center inhabited by middle-income families. Currently, it hosts state-owned business enterprises, department stores, cultural activities, entertainment uses and administrative buildings generating thousands of traveling journeys. (Abdelaziz, 2016). the area of central business district of Cairo is about 2.3 km².

4.2.1. Monitoring of parking spaces at the Cairo Business Center The current parking

Areas in central Cairo will be studied and analyzed through three points: types of parking spaces, geographical distribution of parking spaces, and analysis of parking spaces.

4.2.1.1. Types of parking spaces

There are four main types of parking spaces in the Central Business District in Cairo, which can be summarized as follows:

- **Multi-floor public parking:** There are 7 main multi-floor public parking (Omar Makramm, El Ataba, El Opera, El Bostan, Hilton Ramsis, El Tahrir Square, Ramsis Square).(EEAA, 2018) .
- **Surface public parking:** : There are two main surface public parking in the Study area (Abdel Monaim Riad Square, El Falaki Square). (EEAA, 2018).

- **Informal surface parking (free land area):** It is spread over many places in the study area in the commercial areas and in front of the administrative buildings with a small area .
- **Parking parallel to the sidewalks of the streets:** Parking spaces parallel to the main and secondary streets, which are allowed to wait for cars.

4.2.1.2. Geographical distribution of parking spaces

Table (7) and Figure (14) show distribution of parking spaces in the study area by name, style, number of floors and maximum capacity.

Table 7. Parking spaces in the study area (EEAA, 2018)

Code	Parking facility	Type	No. of floors	No. of spaces
P1	Omar Makram	underground garage	4	600
P2	El Ataba	multi story garage	5	650
P3	El Opera	multi story garage	6 (2 levels)	1130
P4	El Bostan	multi story garage	9	900
P5	El Falaki	Parking lot	-	135
P6	Hilton Ramsis	multi story garage	7	210
P7	Abdel Monaim Riad Sq.	Parking lot	-	500
P8	El Tahrir Square	multi story garage	4	1700
P9	Ramsis Square	multi story garage	3	300

The table shows that the total capacity of public garages in the study area is 6729 vehicles, which is certainly insufficient to cover current parking requirements in Cairo’s central business district.

It should be noted that the project "Sustainability of Transport in Egypt", implemented by the Egyptian Ministry of State for Environmental Affairs, is based on the development of the changing electronic signage system to inform the available parking spaces and parking lots. The project started in 2009 and was designed for completion in 2017. However, (EEAA, 2018), the project not yet fully implemented, as shown in figure no 15.



Figure 15. General public parking in the study area (Source: Researcher).

4.2.2. Analysis of parking spaces

The analysis of the current parking conditions in Cairo's Central Business District is based on an analysis of the current public parking spaces, the efficiency of their geographical distribution, Planning problems related to the garage relationship in its surroundings, and the systems used to operate them to reach the most important measures.

Capacity: According to a survey conducted by the World Bank Group in 2014 on traffic in Cairo, the average traffic capacity of the main roads (for the central commercial district in Cairo) is between 3000 – 7000 vehicles/hour in both directions morning and evening, and private cars are more than 55%. The capacity of parking spaces currently available is limited and insufficient. (World Bank Group, 2014)

Geographical distribution: The geographical distribution of the parking spaces in the study area (Figure 16) shows its concentration on the boundaries of the urban area of the main business area such as Abdel Moneim Riad, Tahrir, Ataba, Opera and Ramses. It is considered an uneven distribution and increases the walking distances between the parking and the working areas. This is due to the accumulation of urbanization and the lack of available land for the construction of public parks with adequate capacity.



Figure 16. Parking geographical distribution analysis (Source:Researcher).

Operating Systems : All the parking lots and parking areas in the study area do not use smart systems to provide service, which leads to random work, lack of information about empty spaces in garages, and increase the time and effort required to receive the service, but some parking areas in the study area using the system Smart payment but not fully where one of the garage staff to pay instead of the owner of the car such as Opera, Tahrir Garage.

Planning problems related to the garage relationship in its surroundings: There are many planning problems related to the garage relationship in its surroundings leading to problems in the efficiency of the work of garages, including the engineering standards for the design of roads such as (physical bottlenecks, turns-U, Poor road surface quality, Speed bumps) . And awareness of road etiquette and manners by various entities such as (no lane discipline, ubiquitous jaywalking, and illegal stops by transit and other vehicles). And traffic management control such as (poor control at intersections, and lack of modern technologies for traffic management). (World Bank Group, 2014).

4.2.3. Recommendations for the development of smart parking systems in the Cairo center

The recommendations and plan for the development of parking systems in the Central Business District in Cairo in particular, and Greater Cairo in general, are based on the application of the different systems of the smart parking, which were explained in the theoretical part of this research in section 3.2, in line with the issues and problems

that emerged from analyzing the current conditions of parking places In accordance with regulation.

4.2.3.1. **At the level of the study area :** the following measures must be taken

- Combine the various techniques for the management and operation of smart parking areas and their application in the management of existing parking areas in the study area.
- For the current 9 parking spaces in the study area, a system should be implemented Parking guidance and information system, providing the main streets and squares with clear electronic screens and providing them with a sophisticated communication system, to facilitate the steering of vehicles towards parking areas.
- Should be implemented smart payment system in a self-sufficient manner, does not depend on the presence of a staff member
- Cairo Governorate must develop an electronic parking system by launching an interactive online market that will create the possibility of reserving parking spaces through the Internet, allowing cars to book their places in advance and paying the fees electronically, and can be used by companies working in the field of programming to launch and manage the site.
- Working to find a set of vacant plots of land in the study area and then contracting with companies that establish automatic parking,

4.2.3.2. **At the level of the study area:** the following measures must be taken:-

- Improving traffic at the entrances and exits of Cairo, addressing bottlenecks, and directing cars to the parking spaces available from regional stations.
- For regional bus and minibus transit stations and terminal metro stations, it is proposed to use the parking and ride system, limiting the entry of cars into the city center, thus reducing traffic congestion and high traffic density and problems resulting therefrom. Examples of these stations (New Elmarg - Abboud – Ahmed Helmy- Almnib - Elsalam – 10th of Ramadan - etc.) As in Figure 17.
- Develop and increase mass group transport services for the development of efficient, well-organized, low-cost and high-capacity bus services in Greater Cairo to reduce the number of small cars that cause traffic crises.

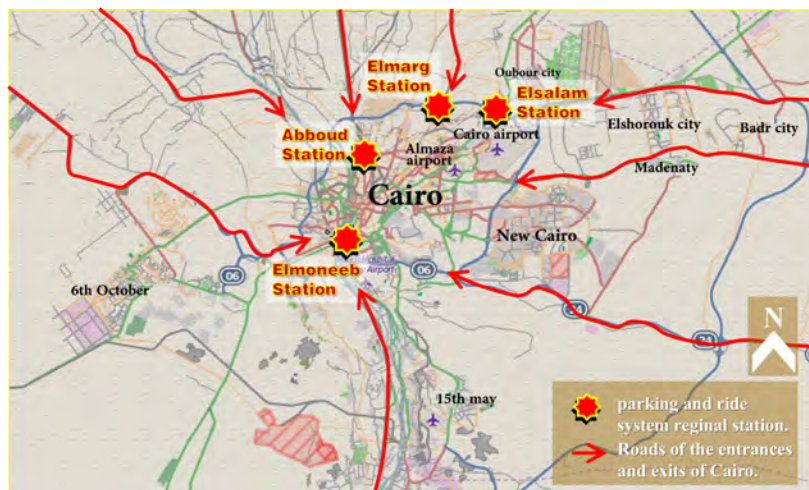


Figure 17. Regional stations in Greater Cairo, proposed to be operated by parking and ride system (Source: Researcher).

4.2.4. Proposed stages of implementation

The first phase will cover the processing of infrastructure and the limited application of intelligent parking systems on the existing parking units. The second phase aims to plan and implement new parking and full implementation of smart parking systems. The third phase is to cover all requirements for smart parking, innovation and development, In table 8.

Table 8. Stages of implementation of the plan and its Executive procedures (Source: Researcher).

Phase	Time Range	Objectives	Executive procedures
Phase I	2018-2023	Infrastructure and limited application of smart parking systems on existing parking units.	<p>Implementation of the transit-based information system (park and rid) in the regional transport stations and the end stations of the Greater Cairo metro.</p> <p>Application of parking guidance and information system on the nine positions of Cairo CBD that have been studied.</p> <p>Raise the efficiency of the infrastructure in the field of communications in Cairo CBD in preparation for receiving electronic payment systems and inquire about parking.</p> <p>Prepare organizational and institutional aspects of system management.</p> <p>Providing funding resources, whether governmental or ongoing, and identifying and inviting development partners.</p> <p>Carry out awareness campaigns for the population and motorists about smart parking systems.</p> <p>Commencement of agreement on the supply of equipment necessary for the implementation of smart payment systems in preparation for implementation in the second phase of the plan.</p> <p>Develop a comprehensive plan for the development of roads, intersections and traffic signals in the study area to solve the current problems in preparation for the acceleration in the application of intelligent parking system in the second and third phases of the plan.</p> <p>Signing agreements with banks and banking entities to equip the various smart payment systems in the framework of the development plan for parking in the capital.</p>

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Table 8 continued

Phase II	2024 -2029	Planning, implementation of new parking, and implementation of smart parking systems completely.	<p>The introduction of smart payment systems in the existing parking, in line with the banking systems and credit cards used by motorists</p> <p>The introduction of smart payment systems in the existing parking, in line with the banking systems and credit cards used by motorists.</p> <p>Start the establishment of automatic parking in the land available urgently and provide them with appropriate smart payment systems, to find an appropriate balance in the geographical distribution of parking places.</p> <p>Develop the necessary plans for the provision of new parking spaces and the development of architectural and construction designs to be equipped with different systems for waiting for smart cars in preparation for implementation phase III, with Identifying the necessary funding resources.</p> <p>Develop and implement regular maintenance programs and continuous development.</p>
Phase III	2030 - 2035	Covering all requirements for smart parking, innovation and developmen.	<p>Implementation of the final stages of the proposed smart cars parking, to accommodate the current shortage, and the expected increase until the target year.</p> <p>Continuing maintenance and continuous development.</p> <p>Assignment of research centers specialized in the development and innovation in the field of intelligent transportation.</p>

5. Research findings and recommendations

5.1. Research findings

- Smart parking is an important mechanism of smart cities concepts, in order to improve quality of life, sustainable development.
- Smart parking have more than one system, which contributes to solving one or more traffic issues and their growing problems, saves time and effort, and has positive economic and social repercussions.
- Smart parking facilities As discussed in five advanced systems, each system contributes to the problematic solution of the problems of parking, especially in the cities of capitals with high traffic densities.
- Smart parking can not operate alone in isolation from an integrated system to develop the transport system, and an urban plan to develop the network of movement and functional relations between the central region and its urban environment.
- The Business Centrer District in Cairo suffers from accumulated planning problems, with planning, economic and social reasons. Therefore, the application of Smart parking systems requires their application within an integrated development plan, taking into account the foundations of sustainability and competitiveness

5.2. Research recommendations

- Raise the awareness of the concerned government agencies and parking designers in the role of different systems of smart parking in the face of the gap between the supply and demand parking lots.

- Combining various techniques of smart parking in crowded areas to increase operational efficiency, and facilitate the flow of traffic to and from parking.
- Investors should be interested in studying the techniques and smart parking systems for underground exploitation and vertical exploitation to allow for the absorption of more cars.
- Optimal exploitation of the available spaces, especially adjacent to the service facilities in the Automated parking
- Don't grant a building license for any facility that does not have enough parking space according to the design and planning standards, and to impose strict control and fines for those who transfer the parking space to any other use.s
- Promote high-level mass transport so that it is a strong competitor to private cars and provide park and ride parking system in regional and domestic mass transport stations.

6. Future search fields

This research recommend completing the study of a series of topics complementary to this subject, as this research has not been able to enter into more technical details of smart parking systems in the CBD of capitals, and therefore it is recommended to study the following points:

- Technical specifications and detailed architectural and construction designs for smart cars, commensurate with the local transport network and systems Detailed financing frameworks for smart parking.
- Detailed financing frameworks for smart parking.
- The role of popular participation and awareness of the importance of waiting for smart cars.
- How to cooperate with governmental and private institutions and the role of each in developing the smart parking.

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8. Appendix A: Terminologies

Table (9) shows the search terminologies.

Table 9. Terminologies (Source: Researcher).

	Expression	Explanation
1	GOPP	General Organization for Physical Planning.
2	E-parking	Electronic Parking.
3	ITS	Intelligent Transportation System.
4	PGI	Parking Guidance Information.
5	VDPs	Vehicle Detection Processors.
6	VMS	Variable Message Signs.
7	PSOS	Portable Software On Silicon.
8	RFID	Radio frequency Identification
9	APS	Automatic parking system.
10	CBD	Central business district.
11	SMS	short message service.
12	EEAA	Egyptian Environmental Affairs Agency.
13	RTA	Road and Transportation Authority in UAE
14	DMCC	Dubai Multi Commodities Center