MEAN stack to enhance the advancement of parking application: A narrative review

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Abstract. Parking is becoming a problem, especially during rush hour. This is an effect of increasing number of private cars that demand of parking space to follow increase. In order to anticipate this key issue of parking, then the smart parking system has been developed. Advancement of smart parking has been a key concern to produce an application system with high performance, flexibility, and scalability in emerging technologies that can provide information about parking in real-time. The empirical study in this area has conducted various parking system reservations, monitoring, and guidance systems that can make parking process easier. This review emphasizes the aim to give a narrative review of the papers in our pool of papers to prove the evidence and provide an application technology advancement to produce a real-time parking system. The review has included 22 papers from our pool of papers which has examined, which are analyzed from used system technology to build the smart parking application. The narrative review was carried out to exposes the existing application parking and compared to parking application that have implemented a MEAN stack. Search terms used in the literature review are applications that have been elaborate a study of smart parking application as a key concern of this study. Synthesis of the papers on the pool has suggested that there is an optimistic reason that a MEAN stack approach might be effective to produce a real-time application high performance, flexibility, and scalability technologies from a smart parking application.

Keyword. Smart Parking, Application technology, Parking problem, parking system Advancement, MEAN Stack.

1. Introduction
Parking process to find vacant parking mostly become a challenging problem for all driver [1], [2], especially in rush hour when demand for parking spot reaches the limit for the availability [3]. This condition may cause a congestion in the parking area, which wasted time and effort [4] just to find a parking space. Another impact is producing more car emission and noise pollution, lead to driver frustration, physical and psychological disorders [5]–[7]. With this issue, a system of smart parking has been conducted to provide a solution using various approaches and researches to overcome the difficulties of parking area [8] by serving an information of vacant space parking [6]. This statement
is the main concern for the authors to discuss a smart parking application for the review. The included paper is an empirical study of the application of smart parking that has divided into a web application and mobile application whether on a pre-trip process or on-trip parking to get the parking information [9]. Conducted smart application applications papers it produces the same advantages which to deliver information about vacant parking space of the way much easier. The included paper that related to smart parking application has been collected in our pool of article, which it would help us to bring the review for an approach to the parking system application.

The access to the parking information and reservation it becomes easier and convenient due to smartphone applications [7]. The included paper on mobile parking-related platforms showing parking spots to drivers [10]–[12], another mobile application is has been introduced following a crowdsourcing-based approach [13]. Overall, most of the papers on smart parking implementations focus on the sensing technology and apps development. In some papers, large-scale deployment of smart parking is a great opportunity to test the sensing accuracy and sensors’ connectivity [14]. Thanks to the ubiquity of web browsers with its cross-platform based which have advanced the technology to deploy the application in both desktop and mobile platforms [15].

Web applications are multi-platform supported, easy to develop and well recognized for its stability. Web apps can be accessed from all devices via the platform’s browser [16], [17]. The web application has proven to be a powerful medium for delivering information and software services over the internet in case of smart parking services [18] for an active, stable and quick communication between cars and parking facilities [19]. Moreover, transition a web application to a single language JavaScript have been increasing significantly in recent years with a growing demand to assist the application especially in web parking application in this discussion [20]. Base on that, JavaScript is used widely by developers in the world due to community support that has been growing [21]. JavaScript is increase along with the presence of a multi-language paradigm of MEAN (MongoDB, Express, AngularJS, Node.js) stack which is based on a single language of JavaScript [22].

From the paper is selected between the interval years of 2011 until 2017, collected papers will be classified into an information system, monitoring system, proposed design methodology, papers on guidance system, and papers on a reservation system. The current paper is conducted to make a narrative literature review in smart parking study, which is carried out to establish the extend advancement of application approach in term of real-time application advancement base on MEAN stack technology. Which is being used currently to enhance smart parking research methods and focused on the state of knowledge in the smart parking application area.

2. Method
In achieving the objectives of this paper to make an evidence of an advancement of smart parking application using a MAEN stack web application. That focusing on a cross-platform application which could be deployed in any devices and produce a reliable application in the real-time process the information for the driver.

The way to realize the mentioned purpose of this research, the authors does it by conducting a narrative review relating to parking applications. Collection the paper that implements great method, conclude their problem, purpose, technology, and feature. The results of each review will be summarized to get a conclusion that the application can be developed to produce the best parking system. The further result will be discussed concluded at the end of this research.

2.1. Search term
The search term as a literature review in this session comes from previous searches conducted on application evaluations intended by various application developments in the smart parking area. When conducting a review, the author is especially interested in developing applications based on MEAN steak. Search terms for applications are also included because this may include application elements that will be used as references in the discussion of this paper. The terms used as keywords in the search for this smart parking application paper are:
To specify the search term to get the paper that is really related to the discussion of this review of smart parking, then the author adds a sub search by adding “AND parameter” then the next keywords following terms were used:

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AND (park OR parking OR "smart park" OR "smart park" OR "smart parking" OR "intelligent park" OR "intelligent parking")
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To anticipate the effect of paper that undetected from the keyword that have been stated above, than the authors decided to add more method to find the paper manually with the following sources as on personal web page with addressed into the field which is relevant base on the collected paper on previous keyword in search term.

2.2. Final pool of articles and the online repository

Next step after the relevant and similar paper as collected and make a study analysis, exclusion proses from unrelated study to this topic, then in our pool of included paper has finalized with 22 papers which is most relater study to this review.

A table 1 and figure 1 has shown papers in our pool by the year when they publish the study. We can state that paper that related to this study has been increasing from 2011 until 2013, then decreasing trend from 2014 to 2015, and last the trend has been significantly increase in 2016. Note that the since the study was conducted in the midst of the year 2018, thus the data for this year are partial.

Table 1. Included paper on pool of paper by year.

| Year | Number of papers | Reference |
|------|------------------|-----------|
| 2017 | 2                | [10], [11] (Aalsalem & Khan, 2017; Liang, 2017) |
| 2016 | 10               | [23]–[31] (Alkheder, Al Rajab, & Alzoubi, 2016; Atif, Ding, & Jeusfeld, 2016; Caballero-Gil, Caballero-Gil, & Molina-Gil, 2016; Charles, 2016; El-Seoud, El-Sofany, & Taj-Eddine, 2016; Garcia, Rose, Sung, & El-Tawab, 2016; Khanna & Anand, 2016; Lotlikar, Chandrahasan, Mahadik, Oke, & Yeole, 2016; Narasimha-Mohanasamy & Jenq, 2016) |
| 2015 | 1                | [32] (Baitalmal, 2015) |
| 2014 | 2                | [33], [34] (Al-Kharusi & Al-Bahadly, 2014; Livio, Fabian, & Samuel, 2014) |
| 2013 | 4                | [35]–[38] (Cosgrove, 2013; Geng & Cassandaras, 2013; Hussien, 2013; Trusiewicz & Legierski, 2013) |
| 2011 | 2                | [39], [40] (Bernspång, 2011; Wang & He, 2011) |

Figure 1. Graph number of include papers by year
2.3. Selection criteria for inclusion of papers in the current review
The aim of review to find previous research which used an application based on mobile or desktop application which engages a mobile or web application. A number of further criteria were specified to select appropriate studies for inclusion in the review. To be included in the review papers had to (a) describe an application based on web or mobile application which contain a guide or map, notification and reservation to a vacant parking space, (b) include empirical evaluation of the application, (c) Scaled from 2011 to 2017, and (d) include an abstract.

3. Result

3.1. Paper identified
Numerous papers in the review has been collected in a pool of paper, the papers is included from identifying process of selected database as shown in table 2.

Table 2. The number of papers identified from each database and included in the review.

| SOURCE        | Identified from database                                           | Include in the review |
|---------------|-------------------------------------------------------------------|-----------------------|
| IEEE          | 66 Identified using abstract title keywords from 2011 to 2017     | 6                     |
| Science Direct| 43 Screened by peer review from 2011 to 2017                      | 9                     |
| Google Scholar| 16 Manually search by relevant studies and similar to previous studies | 7                     |
| **Total Paper** | **125**                                                          | **22**                |

3.2. Paper Selection
To emphasis main discussion of narrative paper on smart parking app we conduct paper from several database of smart parking. Those interval chosen in case to enhance a limited paper in discuss of smart parking application. Also it is for compare traditional and latest technology. Selected database are IEEE, Science Direct, Google Scholar, and other paper that has been collected by author previously. Total paper that collected base on smart parking is 125. After screening and narrowing process, the most related paper to smart parking app is 22 papers.

Those final numbers are produced from the inclusion criteria described in section 2.2, 22 papers met the inclusion criteria and were identified as relevant paper for the current review. The following papers are described and evaluated based on a parking application research methods.

3.3. Problem and purpose of smart parking application
This section is define a problem and purpose of each paper from 22 papers which collected from pool of articles of the review. A common problem that wanted to solve the paper is a time consuming process to find a vacant parking, and a purpose a system that can notify and reserve a space of parking area in a current location. However, problem and purpose of included papers is different to guide them to their research. In table 2 below is describe the problem and purpose from include paper in the review.

Table 3. Problem and purpose included papers of smart parking

| Ref | Author                  | Problem                                                                 | Purpose                                                    |
|-----|-------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------|
| [10] | Liang (2017)            | Issue of parking problem in large city, in campus also it is become a problem which annoys a student in Virginia Tech Campus. | Purposed a mobile application named ParkinVT which focused to produce a user friendly interface design of smart parking application. |
|     | Manually Search         |                                                                         |                                                             |
| [11] | Aalsalem (2017)         | Growing number of vehicle is become a problem to the parking monitoring and | A CampusSense to overcome the problem which encountered while user try to search |
|     | Science Direct          |                                                                         |                                                             |
Ref | Author | Problem | Purpose
--- | --- | --- | ---
[41] | Ahad (2016) Science Direct | Wasted a lot of gasoline and congestion of traffic in cities during parking process. A Park Easy phone application to show the occupancy of cars parks and provide a routing process on it. | Manually search

[25] | Jenq (2016) Science Direct | Finding parking is a problem for a visitors who are new to the cities like New York. Sometimes it is cause lost during the process. Intelligent parking assistance system as a component of the future smart cities. Reduce emission to protect city environment and save time for people. | Science Direct

[26] | Atif (2016) Science Direct | People has frustrated to find an elusive parking spot while taking more time to driving around. Parking Service Provider (PSPs) to capitalize private land properties for parking, relieve stress, create new revenue source, and enlist new entities in intermediate market. | Science Direct

[27] | Caballero-Gil (2016) Science Direct | In recent year a general lack of parking availability is a result from growing number of vehicles on the road. An adaptive recommendation mechanism for smart parking as advantage of the smartphones popularities and the rise of the Internet of Things. | Science Direct

[28] | Charles (2016) Manually search | Rising number of vehicles its follow by challenging task to find a vacant parking space especially at peak hour. Design and implementation the system which provide occupancy, payment, parking permit, and parking analytic in Helsinki area. | Science Direct

[29] | El-Seoud (2016) IEEE | Difficulties with parking are experienced by driver has led to significant social and environmental problems ranging from traffic congestion and pollution, to lost retail and parking revenues. Design the smart parking systems to simplify the parking systems operations, drivers’ satisfaction improvement, increase parking revenue, and alleviate traffic congestion. | IEEE

[30] | Alkheder (2016) Science Direct | In Abu Dhabi (the capital city of UAE), finding a parking at some locations is a real challenge due to the lack of available parking slots in the city. Mobile application to reducing the time wasted in searching for parking and will increase the efficiency of the parking system in Abu Dhabi. | Science Direct

[31] | Khanna (2016) IEEE | Increase number of private car user cause a difficulties to finding an available parking for drivers in present day. Mobile application that is connected to the cloud and helps a user know the availability of parking spaces on a real time basis. | IEEE

[32] | Butowsky (2016) IEEE | The traffic created and the large number of spread-out parking locations. Web application using semantic design for a governmental organization’s parking app to navigate customers to parking structures in conjunction with their destination. | IEEE

[33] | Lotlikar (2016) IJCA | A tedious in searching a parking lot as a result of increasing population. A real time cloud based application to monitoring and reservation parking availability, provide a better services to the end users, and reduce the parking administrator workload. | IJCA

[34] | Garcia (2016) IEEE | A parking challenge at Madison University and need of a smart system to show number of available parking spaces in a particular lot at any given time. Notify drivers of the probability of finding a spot in the target parking lot. | IEEE

[35] | Baitalmal (2015) Manually search | Challenging process task in big city, cause frustrated and distracted the driver. Increasing congestion on the road, sometimes causing accidents, and wasting valuable time. A mobile-base reservation system which considers all nearby parking service providers’ ability to satisfy customers’ requirements and reserve the best parking for the user. | IEEE

[36] | Al-Kharusi (2014) | Inefficient of car park from busy days driver spend long time to drive around in An intelligent system for parking space detection based on image processing | Science Direct
Ref | Author | Problem | Purpose |
--- | --- | --- | --- |
[34] | Livio (2014) | Daily challenge for drivers across the world, due to the increasing amount of cars to find a parking space. | A technique which can resolve parking problem |
[35] | Cosgrove (2013) | High cost infrastructure upgrade, and security considerations parking payment with debit or credit cards, a situation vulnerable to information theft. | Deliver an implementation and a probabilistic analysis from online car parking reservation service using XAMPP. |
[36] | Hussien (2013) | The busiest airports usually creates a long queue of line during car entry and exit | A simple, easy to implementation and low cost solution dedicated for parking lots reservation |
[37] | Geng (2013) | A traffic in urban city caused by vehicles searching for parking | A smartphone application to provide the motorists a real-time information from the availability of spots in parking houses |
[38] | Trusiewicz (2013) | The parking place is costly and sometimes very limited resource in the cities, it cause the air pollution in urban areas, increasing traffic congestion and frustration of drivers. | A design and implement a prototype of Reservation-based Smart Parking System (RSFS) to effectively find and reserve the vacant parking spaces for the driver. |
[39] | Bernspång (2011) | A constant demand for parking from the peoples that using cars for transportation tool. | A design and implement a prototype of Reservation-based Smart Parking System (RSFS) to effectively find and reserve the vacant parking spaces for the driver. |
[43] | Wang (2011) | parking management influences drivers search time and cost for parking spaces, parking revenue, and traffic congestion. | A design and implement a prototype of Reservation-based Smart Parking System (RSFS) to effectively find and reserve the vacant parking spaces for the driver. |

Table 2 above has mention all the problem and purposes from included paper in our pool. It has describe the parking problem has become major issue in any place such in big city/urban city, campus, and shopping mall along with the increase of vehicle number on the road. Resulting a traffic congestion, pollution for the environment, wasting fuel and time and any valuable time. This is can be even worsen especially in a peak hour, it makes peoples who want to find a parking space get frustrated, distraction sometime it is even causing an accident on street or in parking area. This has proven the statement of the problem of this review that has been stated previously. This also become a reason why authors has decided to conduct the review of this studies.

Included paper in our pool provide a solution to make a design and implement an application that they have purposed. The solution that has given is a design and implementation of an application. This problem statement and purpose is emphasis the discussion problem on this review, which also mentioned as a background problem of this study. Whole purpose of included study is aimed to one goal which to solve the problem in parking using a smart parking system.

3.4. Papers categorization
After collecting various papers that have been identified in this review based on one smart application topic that has been determined and organizing as many as 22 papers which have been integrated in the pool of paper that we have made and categorized based on the type of parking application described by this paper: parking information system, monitoring system, proposed design methodology, parking guidance system, and reservation system. These categories are shown in Table 2, along with the
number of papers covering each topic in each category. Also shown is the number of papers that adopt mobile applications, web applications, web applications and mobile applications and desktop application approaches. All 22 papers are summarized in the table in Appendix A with respect to the author; the database source of the paper; research and design approaches and research objectives, research methods or statistical topics discussed and research result of the study.

Table 4. Paper categorization included in the review

| Kind of smart parking application          | Number of papers | Web App | Mobile App | Web & Mobile App | Desktop App |
|--------------------------------------------|------------------|---------|------------|------------------|-------------|
| Papers on information system               | 7                | 1       | 3          | 2                | 1           |
| Papers on monitoring system                | 2                |         | 2          |                  |             |
| Papers on proposed design methodology      | 3                |         | 2          | 1                |             |
| Papers on guidance system                  | 1                |         | 1          |                  |             |
| Papers on reservation system               | 9                | 6       | 2          | 1                |             |
| **Total**                                  | **22**           |         |            |                  |             |

3.4.1. Paper on parking information system

Parking information system is categorizing papers that have been collected and grouped with papers that convey information about the number of parking lots available to driver. Parking information systems can be very useful in order to mitigate the parking search process. There is an extensive literature developing smart parking application that will be described in below discussion.

ParkingVT a mobile parking application on Virginia Tech Campus that developed by Liang [10] in a term to improve the parking experiences and efficiency in campus parking area. The application is using a key factor of user-friendly design interface which developed through an online hybrid platform called Ionic, with front-end of HTML & CSS then import the Google Maps API via ionic using JavaScript language for navigation function. During developing this application a classification of the finding parking level has been determined for the guest, staff, student, and for the faculty. The application design was respectively considered based on different parking requirements and behaviors of the users and deliver the notification about the number of vacant parking on campus area. However it still cannot guarantee the user to the parking spot, depends on who has arrived earlier than they may have been occupied the parking spot in priority.

Narasimha-Mohanasamy & Jenq [25] has developed a web application information system which called ParkIt. This system selecting the parking area in destination location for an available parking lot then shows the detailed routing information, figuring indoor parking map from the database which has been simulated with makeup data on it previously. The application is constructed by web technologies like a MEAN stack to build the parking application system, and HTML, CSS, JavaScript, and bootstrap an open source framework.

A major vision by every practitioner in the world of education is to apply problem-solving skills using techniques that have been learned to solve problems that can be contested in the real world and beyond the lessons. One of the visions that JMU Secure Web-based Smart Parking has realized through Cloud applications it is just what have done by Garcia et al. [24], he has developed a web application by adding a security system and mobile-friendly and multi-platform mobile applications both on iOS and Android platforms to provide information to the drivers who use the application around the number of places available from the expected parking lot. By utilizing the strength of the MEAN stack (Mongo, Express, Angular, and Node) and cloud-based computing, the JMU community will get a close real-time perspective of parking situations on campus.

Since most of the cars at Massey University are in one parking area, video cameras could be used effectively to detect many of them. As Al-Kharusi & Al-Bahadly [33] has aimed system to deliver the information of available parking space using a vision based monitoring system and image processing. The system comparing the parking area by using an image processing between the occupied space and
the empty space by drawn a circle shape in the space in parking space. The hardware and software have been implemented at Massey University. The system is using a Matlab for a software platform and filtering the image from noise using an FPGA platform.

At Swiss City Zurich, getting information on the number of available and reliable parking lots is a challenge they must fight. Livio et al [34] purposed the key feature of the Parking Monitoring and Management Solutions (PMMS) is a system that is intended to estimate and visualize the availability of parking information on the map. The system provides parking location reminders, parking extension times, and parking expiration reminders as an important part for users in using the application and contributing to the parking availability system. PMMS has been designed to handle multilingual interfaces and information about parking regulations for Swiss City Zurich. This parking information application is built using technology from Cordova, jQuery, jQuery, and Apache Tomcat to build web services, and the last is communication between different components using JSON-RPC.

Newer solutions have brought challenges to municipalities seeking to implement these 21st-century parking meters, such as the high cost of upgrading to such an infrastructure, and security considerations for citizens, who often are paying for their parking with debit or credit cards, a situation vulnerable to information theft. As Cosgrove [35] in a SmartPark project has provide convenience through smartphone technology that allows users to pay for parking with their smartphone by simply scanning a QR code. The system has delivered (a) a mobile Application for a single platform (Android), (b) Web server (Website), and (c) User Manual. The application was implemented using a MEAN Stack, HTML5, Bootstrap, jQuery, and Backbone.js.

Mobile application base in various frameworks that can simplify the process of developing parking applications as studied by Bernspång [39]. This work was developed using a cross-platform approach of PhoneGap an open source framework and web technology that can be run through a web browser. The back-end for this project is implemented in Python and runs on Google App Engine, Django-nonrel to speed up development, to simplify JavaScript language a coding from Xui is applied, and finally display search results on maps using the JavaScript API V3 system from Google Maps.

3.4.2. Paper on parking monitoring system

Parking monitoring system is a system that utilizes vision-based systems, which are used to monitor parking lots and get information about available parking lots and to monitor parked vehicles on parking lots that have been integrated with this system.

The CampusSense smart parking system put forward by Aalsalem & Khan [11] has been integrated with the Automatic Number Plate Recognition (ANPR) camera to record to monitor vehicles in the parking lot. This application is responsible for finding a car if the driver forgets the location of the parking lot, helps the security unit to search for and chase people who damage or block other cars, while parking the wrong car in the parking lot. This system was built specifically with the aim of helping the security department to ensure the safety of students, teaching staff and staff members when parking the car. This mobile application prototype was developed using Android Studio, a SQL Server database and developed interfaces using C#.

Increasing the productivity and service operation is the main purpose of all smart parking system. Like a Park Easy the proposed web App system that has been applied by Ahad et al [41] which is an application that displays information about the availability of parking spaces. The information is based on users who enter parking addresses and choose a parking space which integrated with this system. Parking space is detected using a sensor monitoring techniques with cameras used as sensors to take photos to show car park occupancy. Then the system will provide automatic messages that include possible shortages of the route of the parking. When the driver reaches the parking lot, the street parking meter automatically detect the number plate, and forward a message to the parking administrator.
3.4.3. *Paper on proposed methodology*

A cities which implemented a smart system, they also will taking a part to provide a parking information system and smarter parking guidance system that interoperates between service operating systems in parking spaces and vehicles. Design methods have been intended in a variety of study to producing the best application system that can help car users to find parking availability.

As done by Atif et al [26] on their work-in-progress contributes to finding the shortest and most efficient path when entering and leaving the parking lot. This system is designed to produce an innovative parking system that also prioritizes security and privacy, and also a system that is very important in managing access controls at various levels including sensors, services, and parking application levels that they have designed.

Caballero-Gil et al [27] has made a parking solution design using mobile application automation using a systematic approach and uses a combination of several advanced technologies and mathematical forecasting methods to model driver behavior. This system applies the idea behind a modified version of the game of life, to try to reduce the time to find parking space availability. Application technologies used in this design are Node.js, Express.js, MongoDB, Mongoose, Bootstrap, JavaScript and QR codes, NFC tags, and BLE Physical web beacons in determining parking coordinates.

Daily business activities reveal that the use of intelligent systems has become the most common in the world contributing to its efficiency and flexibility. Which makes El-Seoud et al [29] make a technology hypothesis that will help build a mobile-based software system and be able to calculate and communicate that fully plays and integrates elegantly with users in real-time. The results of the key hypothesis have been proven that the results of the study have a positive impact on the dimensions of practice using smartphones or desktop computers in the advancement of intelligent parking systems.

3.4.4. *Paper base on guidance system*

Smart parking that uses a guide system in this classification is an integrated car parking system that helps the driver to identify an empty parking space and provide guidance in the form of a guide to the expected parking lot. Smart parking systems can also include ways to calculate and pay for the time spent in the parking lot to maximize the functionality of the parking system created.

Charles [28] designed a smart parking design and system that was applied to the Helsinki area, concentrating primarily on the architecture and hardware needed. This system allows drivers to check previously available parking lots, pay parking fees, get electronic parking permits, and parking analysis to authorities for city planning. This system is built based on WinSpot (LoRa gateway) and WinNodes (LoRa Active RFID TAG). To prevent the concept Django along with a spring framework is developed the pilot version.

3.4.5. *Papers on reservation system*

PRS would require the establishment of parking reservation operations information centres, a communication system between the users and the PRS, real time monitoring of the current parking availability, and estimates of the anticipated demand [8]. The users would be able to reserve a parking space and receive a response from the PRS through a variety of communication media such as telephone, fax, or the web.

A survey has been conducted on Abu Dhabi citizens in terms of searching for a parking space inside a mall parking area and the affected they will visit the malls. Alkheder et al [30] have designed a mobile application called ADIP to show roadmap initiatives to solve some of the problems of indoor mall parking areas in Abu Dhabi City, get the nearest mall, see parking status, mall selection, enter / register, and check booking. From the ideas suggested in this study will help people to make the right decision to visit the mall at any time and will make them feel more comfortable in finding an empty parking space, thanks to algorithms that will save their time and effort. This system was designed using software from the Google App Inventor system, namely Android Mobiles, in developing Android Applications using an IDE web browser.
In term of smart parking application the Internet of Things and Cloud-based technologies has enhance the possibilities to support smart cities program. Khanna & Anand [31] with his propose to provide real-time information regarding the availability of parking slots in a parking area. Users from remote locations could book a parking slot for them by the use of the mobile application. The application is developed in Apache Cordova and Angular.Js framework using JavaScript as a programming language which connected with The IBM MQTT server is hosted on a cloud.

Butowsky et al [42] conducted a studies on the development of cloud-based applications that support the improvement of Web applications, programming, user interfaces, and semantic web solutions. This application recognizes the destination of the city parking structure and, using GPS to determine the position of the car, as well as voice commands to direct the user to the parking garage Macy to get the vacant parking. This application interface is built based on HTML, CSS and JavaScript, and tag-based networks.

Smart parking systems have been proposed in various methods to provide better service to end users and improve overall management of the existing parking system. Like the cloud-based smart parking application created by Lotlikar et al [23] which allows the reservation process and monitoring parking availability in real-time to provide the best service users and simplify the parking administrator's tasks. All applications have been created using AWS Elastic Compute Cloud (EC2), MySQL, Apache, and Android Studio databases.

The smart parking system is always aimed to save users time and allow them to know ahead of time when and how to reach their guaranteed parking space, instead of having to travel to their desired destination unsure of where to park their vehicle. Baitalmal [32] has proposed a mobile-based reservation system then compared the system with a map-based system using a questionnaire. The system can feature license plate recognition via the smartphone camera to ensure accuracy by reducing human error while the system was integrated with the Ministry of Transportation database. The system could feature not only short-term reservations but also a long-term parking such as weekly or monthly reservations. Connection clients and parking service providers it is using the web server Apache HTTP server and the database (DB) server uses software called PHPMyAdmin.

Based on the fact that most of the congestion is caused by the driver to find a paring has made strong enough reason for Hussien [36] has developing this online car parking reservation service system to improve the service to the client's website of his smart parking application by creating a user interface using graphics and web user access to order parking lots, pay online, update the reserved space before the exit date, and find a way to the available free space and order status before they headed to the airport. The following technologies were used to realize the system are XAMPP web server solution stack, Apache technology, PHP a server-side scripting language, MySQL database, JavaScript a scripting language of the web, style sheets a content of the browsed pages, HTML5, and script editor.

The process of vehicles looking for a parking lot almost contributed 30% of traffic congestion in a central urban area which takes around 7-8 minutes. Based on this issue, Geng & Cassandaras [37] has deployed a Smart Parking Allocation Center (SPAC) in 27 parking lots at Boston University. This system utilizes technology to detect parking space availability and driver localization. The Parking Resource Management Center (PRMC) collects and updates all real-time parking information and disseminates it via VMS or the Internet. This project has used a vision-based system that has been integrated with the camera and uses standard image processing algorithms. Information obtained in real-time is published and updated on the web to be submitted to client-side applications, based on a smart phone application that allows users to send parking requests and get reservations anywhere and anytime.

Trusiewicz & Legierski [38] proposed a reservation system for users of other communication channels that are around cellular networks - Unstructured Supplementary Service Data (USSD) and deliver alternative solutions between the driver and the parking reservation system. The system can automatically book a place, recognize the end user's car or mobile phone and navigate the user to an integrated parking lot. Implementation of a parking system based on reservations, especially in cities
to manage parking lots. The user interface is built using AJAX technology, JSON, JavaScript as well as Microsoft Internet Information Server is this application container.

The last for parking reservation system on our pool is Wang [43] who have designed and implemented a Reservation-based Smart Parking System (RSPS) prototype that can effectively allow the driver to find and order a vacant parking space. In real-time monitoring the parking status of the sensor network that has been named in the parking lot, the reservation service is affected by changes in the physical parking status. Drivers can access this application through their mobile devices. This project is made of several components such as MySQL for the repository and minor database, JSP to implement the web service, Apache Tomcat as the web environment, and last for the sensor program is using TinyOS and nesC to develop specific applications.

4. Discussion
This narrative review is aimed to provide information and confidence that the MEAN stack can provide applications that can be accessed in real-time. All collected data in our pool is 22 to expand more previous work and previewing the smart parking enhancement method that has been done. Key concern of this review is contains a problem, purposed solution, supported app technology, research approach, application platform, feature from included paper. From those main concern to be review then we have classify the papers into: a) system based on the parking information, b) while in progress proposed methodology, c) parking guidance system, d) parking monitoring system, and e) parking reservation system.

As shown in table 2 problem in parking area is has become a challenging task from included papers on the review. The issue is from the number of the cars has grown and demands of parking space are as well follow increasing, results in the vulnerability of accumulating vehicles in the parking area to find an empty parking space. To produce a better application advancement is it important to do a qualitative approach to mapping the real problem and conclude the problem solving that is really needed by the drivers as done by Liang [10] and charles [28]. Some application are considering the variety parking behaviors and decision that made by the driver during to find an available parking space. By those variety consideration to develop the parking system on this area should be contain the information, communication system, and friendly approach to the driver. By those variety consideration to deliver the solution to parking problem, the included papers has contain an application system that support the monitoring system, information system, and employ the system to the driver.

Massive progression of smart parking has developed with advanced innovations. The included paper in our pool has collected which contain an interface design, system design, and performance calculation in term of application efficient and time reducing. Advancement of smart parking is carried out using qualitative research in measuring time and energy reduction by simulating the system over the computer and implementation the system primarily, to determine the impact of smart parking using Spearman correlation analysis, and validated the hypotheses using pilot test. Vacant parking detection is divided into vision base, sensor base, marked up the database. Whereas, the system design and the developed applications it has deployed by using a combination of the elements like sensor detection, maps direction, payment system, QRcode recognition, guidance system, mobile application, web application and other as proposed by each paper.

In terms of its ease to run on multi-devices, implementing the web application is a further innovation which can optimize the advancement on the area of smart parking application. Latest technology like a web application base on MEAN Stack is a reliable system to produce an application in terms of fast, scalable and real-time in conveying parking information and can be deployed across the devices. This solution has been brought by some paper in the pool as done by Narasimha Mohanasamy & Jenq [25], Garcia et al [24], Caballero-Gil et al [27] , and Cosgrove [35] that implemented the MEAN stack which has contains all the requirement for mentioned solution in term of producing a high performance, flexibility, scalability, and real-time application into their system to solve the challenge in parking problem.
Moreover, all of the testing’s is important to do in developing an application and carried it out so far to strengthen the evidence that the non-relational application like they have purposed to get a better solution, more extensive testing needs to take place on a large set of smart parking application that would be functionality to ensure there are no hidden design flaws.

In the future, it needs advancement that can combine real-time elements to fill the gap that mentioned by Liang [10]. That is by presenting a system that can provide information in real time as long as the user goes to the parking lot expected. Then identify the impact that produced from the smart parking effect contribute to the city, parking owner, the environment, and the user.

5. Conclusion

The review as indicates that future advancement of smart parking is directed to non-relational, and uses of a smartphone. Most of the included paper has using JavaScript language to influence the system that they have been developed. Smart parking system based on MEAN stack has the general thrust of the evidence was positive and there is a reason to be optimistic about the potential of a smart parking advancement approach. A recent year from 2013 to 2017 it’s been a lot of then implement MEAN stack component technology.

This technological advancement can include developing applications based on reservations, information and even guiding drivers to shorten the parking process. Due to, the non-relational has proven to be a reliable choice for fast, scalable and real-time applications which a benefit while implementing a MEAN Stack base smart parking application. Optimized the process to find a vacant parking and enhance the advancement of the system. Smart parking itself is has proven in by the included paper in the review that will against the problem of parking which reducing the time and another valuable resource that been wasted during the process to find parking manually.

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Appendix A. Collected papers in the pool

| Research approach, study design and aim | Topic | Author | Application | Result |
|----------------------------------------|-------|--------|-------------|--------|
| Information system (n=7)               |       |        |             |        |
| 1                                      | Qualitative: Numbers of 21 participant has involve to implement the usability test including 2 professors, 2 guests and 20 students. | A user friendly interface design. | Liang (2017) Manually Search | ParkinVT a Mobile App vacant parking information system. | This system has divided the difficulty parking into easy for Guest and Staff, medium for faculty, and hard for the student. Given usability testing and exit survey to the participant satisfaction evaluation then improve the ineffective parts. Experimental result an intelligent System which deliver reservation to parking space and embedding maps as guide. |
| 2                                      | Deliver an application development: Prototyping intelligent parking to find and route user (or auto-driven car) to a nearby parking place and invite the garage owner to participate. | a prototype Pre-trip parking reservation system | Jenq (2016) Science Direct | Web app trough smartphone devices | |
| 3                                      | Deliver an application system that allows a student/faculty/ | Smart parking information system. | Garcia (2016) IEEE | Web application and mobile apps | The JMU Secure Web-based Smart Parking via the Cloud initiative is to implement a system that utilizes |
| Research approach, study design and aim | Topic | Author | Application | Result |
|----------------------------------------|-------|--------|-------------|--------|
| staff/visitor to know how many available parking spaces are in a particular lot at any given time. | Visual detection of smart parking | Al-Kharusi (2014) | Desktop App to inform vacant parking. | RFID technology to track parking availability on JMU’s campus. |
| Qualitative: proof of concept to develop one of the best user experiences available to help find available parking spots in real-time. | Design and prototype of a smart Parking | Livio (2014) | Mobile App | An image based method of detecting the availability of a car park was modelled and tested with different occupancy scenarios of car parks. The method of analysing an aerial view of the car park has been presented step. |
| Deliver an application: compare the time searching a parking spot without the application with the time using the PMMS. | a designed payment system | Cosgrove (2013) | Mobile and Web App | The PMMS has been evaluated by its efficiency in terms of the time needed to find a spot. Collects and processes data about available parking places and their tariffs within an area. |
| Deliver a system: describe parts of a system that if fully implemented could help frustrated drivers find available parking spots | Real-time parking space information | Bernspång (2011) | A smartphone application | Multi-story car parks and parking lots the cost for deployment system is inexpensive due to the low demand for sensors compared to those that require a sensor for each parking spot. The system has works and can indeed provide real-time information about availability in parking houses. |
| Monitoring system (n=2) | A monitoring system. | Aalsalem (2017) | CampusSense a Mobile App. Locate the vehicle using map, retrieve vehicle owner information form management system. | Automate the existing manual parking management system with efficient and effective use of the parking lots. Conducted a survey by distributing the questionnaire to the students, faculty and staff members the survey has confirm the car parking problems faced by the participants. |
| Both: 88 persons participated in the survey out of which 53 were students and 35 were faculty and staff members. | A monitoring system and guidance. | Ahad (2016) | Mobile App to monitoring vacant parking and then given the shortage route to the spot. | Detection of vacant parking and shortage route to the parking place with the help of smart phones which mainly helpful in reserve the parking spaces before the time of need, Gives the suitable way for utilizing the money and techniques and it also gives better revenue to the investors. |
| Proposed esign methodology (n=3) | WIP parking-systems’ cloud | Atif (2016) | Parking Service Provider (PSP) | Reveal a multi-layered system of PSP-business model through |
| Research approach, study design and aim | Topic | Author | Application | Result |
|---------------------------------------|-------|--------|-------------|--------|
| space management from a purely physical business to a business that transforms parking into a computational service. | Performance calculation of proposed system | Caballero-Gil (2016) Science Direct | Lightweight Android application | Performance of the proposed approach has been evaluated by conducting computer simulations and real experimentation with a preliminary implementation and shown the strengths of the proposal in the reduction of the time and energy costs to find available parking spaces. |
| Qualitative: parking facility with 152 parking spaces is considered, with parking spaces on the right, on the left and in two rows in the middle. | Reservation-based parking system prototype | El-Seoud (2016) IEEE | Mobile and Web App | A positive significant relationship between the independent and dependent variables related to dimensions of dominating practices in using intelligent systems and the dimension of enriching performance quality of using smart parking via mobile or computer at a significance level less than (0.06) which proves the validity of the research key hypothesis about the positive impact of practices dimensions of using mobile or computer on the enrichment of smart parking system. |
| Guidance system (n=1) | Parking assistance | Sewagudde (2016) Manually search | Smart parking system App using guidance of LoRa and IoT | The result has indicated that it is possible to predict the occupancy up to an hour with the certainty ranging from 65% to 95%. |
| Reservation system (n=9) | Problem solving of mall parking | Alkheder (2016) Science Direct | Mobile App base on real parking problem in Abu Dhabi malls | Majority of the respondents (226 out of 500, 45%) confirm that there is a real problem in searching for a parking space in the designated mall areas. |
| 14 | Deliver an application: creating low-cost, low-power embedded systems are helping developers to build new applications for Internet | Smart parking reservation system | Khanna (2016) IEEE | Mobile App of smart parking system connected to the cloud | Improvement the parking facilities of a city and thereby aiming to enhance the quality of life of its people. |
| Research approach, study design and aim | Topic | Author | Application | Result |
|----------------------------------------|-------|--------|-------------|--------|
| of Things. Smart cities to undertake actions in order enhance the efficiency their parking resources thus leading to reduction in searching times, traffic congestion and road accidents. | Parking Reservation and guidance system | Butowsky (2016) IEEE | City of White Plains parking app a Mobile-base App | Represented a case study of a smart city Web application that was designed for CWP parking app. The findings of the case study were represented via a number of use cases in this paper. Has represent the ontology-based knowledge representation in order to. |
| Deliver an application: Explore the ontology matching techniques and apply them in the parking applications to evaluate and measure whether the ontology-based solution can increase | Monitoring and Reservation system | Lotlikar (2016) IJCA | Mobile and Web app | Produce a cloud based smart parking application which enable real time parking availability monitoring and reservation thereby providing better services to the end users as well as reduce the workload of the parking administrator. |
| Deliver a system: observed demanding easier and less time-consuming parking facilities. Drawbacks proposed system to eliminate enhancement the overall performance. | Reservation system | Baitalmal (2015) Manually search | Mobile-base parking App | More than 90% believe that our proposed PRS is more user-friendly and contains less numbers, which helps them achieve their goal. Moreover, more than 85% think that it is faster and more usable to make a reservation with our system. Finally, 80% like our PRS and might use it to find parking; they would use it more frequently than a map-based online system. |
| Quantitative: 15 participants in our usability test, range was between 25 and 59 year with different academic background, 8 males and 7 females | Online car parks reservation system | Hussien (2013) Manually search | Pre-booking desktop App | The drivers can easily be allocated a vacant parking lot in the airport area based on the information displayed on the booking tools in the web page. |
| Deliver a system: implementation and a probabilistic analysis of the mart parking reservation application to are to minimize the queue time at the airport. | Allocates and reserves optimal parking spaces | Geng (2013) IEEE | a smartphone application and real-time parking information website | Simulation results show significant performance improvements over existing parking behaviour, including the use of guidance-based systems. Moreover, (T) can be further decreased using the IA policy mentioned earlier. The system is being used by approximately 30 registered users. A pilot study is ongoing to analyse utilization and user cost data and collect feedback on system usability. |
| Deliver an application: Examine the use | Parking reservation | Trusiewicz (2013) | Mobile app without requires internet | Using this system car driver can reserve a parking spot on the fly in |
### Unstructured Supplementary Service Data (USSD) as a communication channel between driver and parking system. USSD

#### Deliver an application:

**Application:** Prototype of Reservation-based Smart Parking System (RSPS)

**Result:** Experiment results show that the proposed reservation-based parking policy has the potential to simplify the operations of parking systems, as well as alleviate traffic congestion caused by parking searching.

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