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RIT

iValet – A smart parking reservation system

By

Aaisha AlRefaei

A Capstone Submitted in Partial Fulfilment of the Requirements for the

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Graduate Capstone Approval

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Abstract

In the current time with the continuously increasing population in the world generally and in big cities like Dubai particularly, many problems arise related to traffic and transportation. Due to covid-19 virus spread pandemic, WHO is submitting different regulations and recommendation for the need of social distancing along with avoiding any activities that might increase the possibility of the virus spread and minimize the number of infected people to save more lives. The need for decreasing the usage of the public transportation in Dubai have created parking issues in the city, streets, and buildings. One of the preferred solutions by people to overcome the long searching time for a parking lot and to reduce the fuel usage is to use the valet parking service in different city buildings, but many of them now are scared to allow strangers to use their car in the valet service. In this regard, the idea has emerged of having a smart parking reservation system that is connected with the RTA and the traffic police. The system consists of a hardware part implemented in the parking lot, and a software part where the user can search for a vacant parking spot and reserve it with in-advance payment using his/her smart phone.

Keywords: smart-city, parking, reservation, smartphone, cloud-based server, real-time data

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Chapter 1

1.1 Background

The urban population is increasing rapidly, the studies showed that around “Two-thirds of the world human population will live in cities by the year 2050”, which means that cities managements will need for re-considering areas allocation and transportation to contain the increased population (Cole, 2019). The demand on personal use vehicles is increasing as well, after the covid-19 pandemic there were recommendations for social distancing from the world health organization (WHO) (Coronavirus disease (COVID-19) advice for the public, n.d.), therefore, people started avoiding public transportation to minimize the spread of the virus among passengers (Vos, 2020). This has initiated an extra demand on private transportation and thus extra demand on public parking lots. In Dubai, the number of vehicles in 2014 has doubled since 2006 for an annual increase of 8.2% beside the huge number of vehicles entering from another cities, while there are only 166,000 parking spaces across the city (Tesorero, 2018), of course the number has increased in 2021 in both population and vehicle parking spaces, but the problem has not been solved yet. In the other side of the world, Studies have shown that drivers in the USA are spending 17 hours a year searching for parking lot. According to USA Today newsletter “an estimated \$345 per driver in wasted time, fuel, and emissions, according to the analysis by INRIX, a leading specialist in connected car services and transportation analytics.” (McCoy, 2017)

1.2 Statement of problem

After the hit of covid-19 pandemic, the world health organization (WHO) and governments published several recommendations to contain the spread of the virus such as to keep social distancing and avoid unnecessary traveling by public transportation. Cities with high population have a limited number of parking spots and with the increase in populations and personal vehicle usage the drivers are having a problem in finding a proper parking lot. One preferred solution for many drivers was to use the valet parking services, but with the covid 19 pandemic the managements has initiated some measures to use this service as written in (Workplace Safety Related to the COVID-19 Pandemic, 2020). People nowadays are frustrated to find a suitable parking spot in congested areas and are getting scared to use the valet parking service avoiding covid-19 virus infection, so the idea of replacing the valet service with pre-reserved parking lot came in mind, this designed system will serve those people who refuses to let strangers to park their vehicles, or people who are in hurry, beside minimizing the tension while looking for a parking lot.

1.3 Project goals

Smart valet parking reservation system (SVPRS) is a smart system that manages parking mechanism for drivers, where they can access to the real time data of available parking slots using a developed smart phone application. The smart phone parking app allow users to find available parking lots, reserve their preferable lot and then pay reservation fees online.

How the pre-reservation car parking system will replace the current valet parking service in Dubai? The objective of this research is to present the new idea of car parking reservation system that help drivers to reserve a parking spot instead of using the valet parking service.

1.4 Methodology

This paper aims to provide a new self-parking solution in Dubai replacing the regular valet car parking system, encouraging people to use a contactless valet service. The project will contribute with the global concerns to reduce fuel consumption and emitting of CO₂ and greenhouse gasses beside the fact that a pre-reservation of a parking spot would reduce the time spent on searching for available parking lot. Many solutions were proposed in the literature and studies conducting the same area of interest. However, the idea of iValet emerged after studying the previously published and implemented solutions with the concern of enhancing the current situation through practical and easy to use application features benefiting from the new emerging technological concepts like the Internet of Things (IoT), Cyber-Physical Systems (CPS) and Smart Connected Products (SCP) (Zheng, Xu, & Chen, 2018). However, this project could minimize the implementation costs by adding on the current attached smart parking components like the LEDs, sensors and cameras at enclosed parking spaces. Therefore, the research process is done using RIT library and Google scholars to extract the information needed for the new idea. A questionnaire by google form was distributed online to people live, work in Dubai and the visitors of the emirate to see how they are interacting with the idea and for how much they are willing to pay to reserve a parking lot...etc. As this project could be implemented for a commercial use and demanding on the results provided by the survey, a business model has been prepared.

1.5 Limitations of the Study

As per the lack of funding to implement this project in real life, this paper will only provide a description of the solution project, the needed components for it and the app

features for good user experience. One of the goals of this paper is to give a solution with minimum cost using the current smart-parking system that shows the lot's vacancy by LEDs and sensors, therefore the project is most applicable for the enclosed areas.

Chapter 2 – Literature Review

Through the years, many researches have been conducting the area of smart parking solutions for smart cities, these solutions have economic and ecological impact which reduces time spent on searching for a parking thus reduces the power consumed and harmful gasses emission e.g. CO₂ and greenhouse gasses.

Many solutions were provided in the literature that manages parking reservation for a single parking lot or an area of car park with gates that opens when the car reaches the reserved parking lot. A smart phone application is used to make a reservation through internet connection and provide a cashless/online payment pre or post leaving the parking. The gates open using RFID technology, a tag is implemented in the car and a reader on the gates. In addition, the parking lot is equipped with an object sensor/detector either it is an IR sensor, CCTV camera (Kotb, Shen, & Huang, 2017) to detect the presence of a car inside the parking lot or they use a magnetic sensor (Sifuentes, Casas, & Pallas-Areny, 2011) or a combination of more than one. In these mentioned solutions the RFID tags are containing the car data i.e. car plate number, or driver's data saved to a database, that is read by an RFID reader implemented on the gates (Hassoune, Dachry, Moutaouakkil, & Medromi, 2016) (Kotb, Shen, & Huang, 2017) (Pham, Tsai, Nguyen, Dow, & Deng, 2015) (Hainalkar & Vanjale, 2017). Wireless connection with ZigBee's also is used in (Wang & He, 2011) that uses the driver's smart phone Bluetooth or GSM service to locate and guide the driver to the parking and open the gates. A car antitheft mechanism is introduced in (Hainalkar & Vanjale, 2017), connecting traffic police with the parking management system. Any failure in providing the same driver ID information while leaving the slot will lead to send a message to the police app so they can track the car in case of any

complaints from the car owner. Another study presented an antitheft and a secure smart car parking system based on Quick Response Code (QR Code) and IoT technology, where the car enters the parking lots by scanning a smartcard as a parking ticket and a QR code of the vehicle's information then sends the encoded plate number and owner's phone number to the cloud through a Java program to open the gates for the driver. To open the gate to exit the parking lots the driver should scan the same smart card and vehicle's QR code, or the security will be alerted, and the vehicle's information will be saved for the traffic police investigation. (Hoq, Paul, & Tariq Ur Rahman, 2019)

User or the driver's satisfaction is a priority in smart cities where the solution must make the process of searching for an optimal parking slot in the preferred time for the driver is important. Thus in (Boudali & Ben Ouada, 2017) we can find a multicriteria smart parking reservation system mathematical algorithm. A cloud based smart parking system operation mathematical model were introduced in (Pham, Tsai, Nguyen, Dow, & Deng, 2015), the algorithm manages the searching mechanism for a parking at lowest cost and is able to forward the car to another vacant parking lot in different parking areas connecting all the parking together. The system was implemented and succeed in reducing the difficulty in finding a proper car parking and minimizing the searching time.

A case study was conducting a real-world parking management system in the central areas of Jiaxing in China by incorporating the smart phone application and Internet of Things (IoT) technology with a parking space robot which measure the parking status and exchange data with RF IoT gateway (Lin, Wang, & Chen, 2020). Another case study was conducted in Surabaya Downtown Area in Indonesia using a programmed smart phone application 'SORAY' that manages the reservation queue based on the capacity of the parking area, location of the car and

time to reach the parking lot. SORAY system optimize the queue using annealing based heuristic algorithm and calculate the distance by Haversine formula. (Safitri, Pratiarso, & Zainudin, 2020) GPS services, Blockchain and crypto currency were utilized in (United States Patent No. US2019362457 (A1), 2019), allowing the smart parking system to manage locating, reservation and pay the parking fees after leaving it.

In (ELKHALIDI, BENABBOU, & SAEL, 2020) the paper is summing up many research's intelligent parking reservation system criteria, assessing the different parking reservation methods and techniques upon the needs and desires of the drivers to find the optimal solution to implement in real life such as single or distributed reservation, travel time and car/parking locating services.

After reviewing the published papers, the majority of the given solutions seemed to have similar approach which manages either a permanent parking spot for a vehicle with its data saved in a tag attached to it, or a second approach of an open space parking area management with robots that exchange data of the parking lot status to the user's smartphone through the internet. The user can search, reserve and pay the fees online via an application. In the second approach, the parking lot could be reserved for a limited time only and in case of time extending the fees will increase. However, in the solution given in this paper, it will provide the pre-reservation service with online payment in a simple and easy way, no time restriction during the service working hours and no extra fees required. The new solution will require no more than few additional parts to the current enclosed parking lots smart equipment like the objective detector with switching LEDs and a server that exchange data with parking lots to present the vacancies on an attached screen and more details in the next section.

Chapter 3- Project Description

A parking lot booking system is a new way to reduce the time spent on searching for a car parking spot, thus reducing the pollution and fuel usage, also avoiding direct contact with others and achieving social distancing. In addition to that, it is a good way to increase the revenue of city's management and/or valet companies by utilizing latest concepts of data-driven cyber-physical systems (CPS). This paper presents a new idea of smart parking system replacing the valet services in different landmarks parking slots, airport, shopping malls, restaurants and cafes. There must be a proper car park area and a good number of visitors to the place who are willing to pay in advance to book a slot.

The Smart Valet Parking reservation system (SVPRS) will consist of a hardware device connected to an online platform to operate, cloud-based server, and a software to connect the user (driver) to the system. The user or a driver can use the iOS or Android smart phone application to access the system, similar to the idea of booking a cinema seat, they can see the available parking lots, and choose one to reserve. All the parking lots will have a unique code or number, once the user chooses a parking, he can proceed to payment online after entering the car plate code and number. When the payment is done the data will be saved in a cloud database, a QR code will be generated in each reservation and will be sent to the user to scan it once arriving to the car park using a QR code reader attached to each parking lot, figure (1) is showing the flowchart of in-app reservation process and figure (2) is showing the system after making the reservation and car arrival to the parking lot. Two LED bulbs will be implemented at the top of the parking showing the status of the parking, 'green' for available parking lots, 'red' for occupied. The parking lot is equipped with a smart objective detector that will sense the presence

of a car in the parking, exchange real-time data with the server and switch the LED. Also, the parking lot will have an alerting device in case the car is in for 3 mins without scanning the QR code, the alert will keep alerting and the LED will stay on 'green' until providing the right code. The system could be connected with the Road and Transport Authority (RTA) and the traffic Police to release fines in case of any violence to the parking reservation policies e.g., cars park without reservation or at wrong parking lot. A 20 minutes waiting time post reservation, if the car didn't show up in the reserved parking lot, the reservation will get canceled and only 80% of the paid amount will be refunded as the remaining 20% will be considered as service fees.

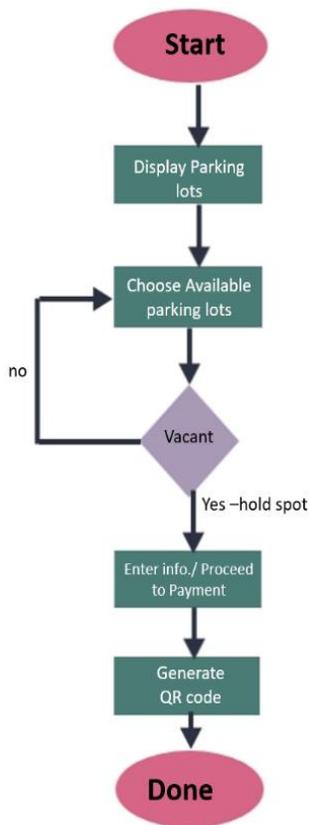


Figure 2 Flowchart of in-App reservation process

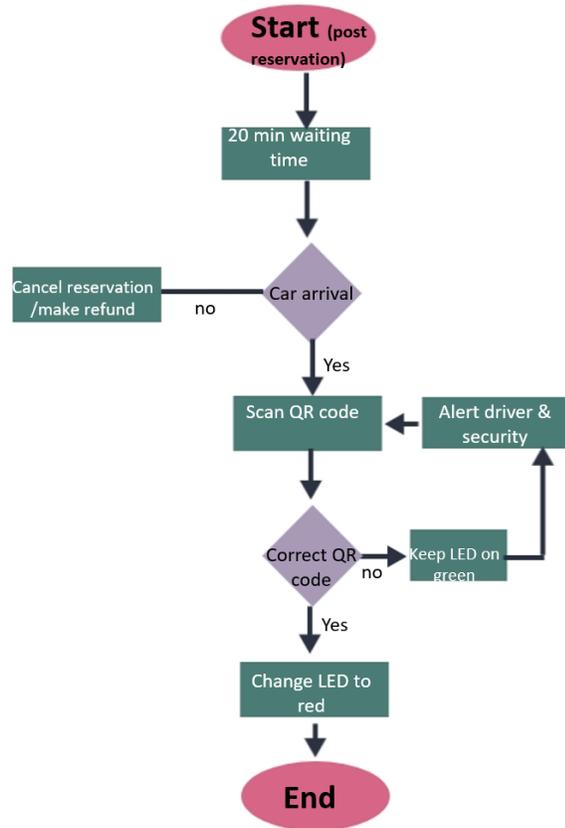


Figure 1 Flowchart of iValet system post reservation

The new smart solution is replacing the conventional car parking valet service by adding more features to it like the GPS to guide the user to the reserved parking lot and the way back to the car all by a readymade algorithm by the App developing company.

3.1 Hardware

The hardware components of the system will be implemented as shown in the figure (1) below and described later on in table (1):

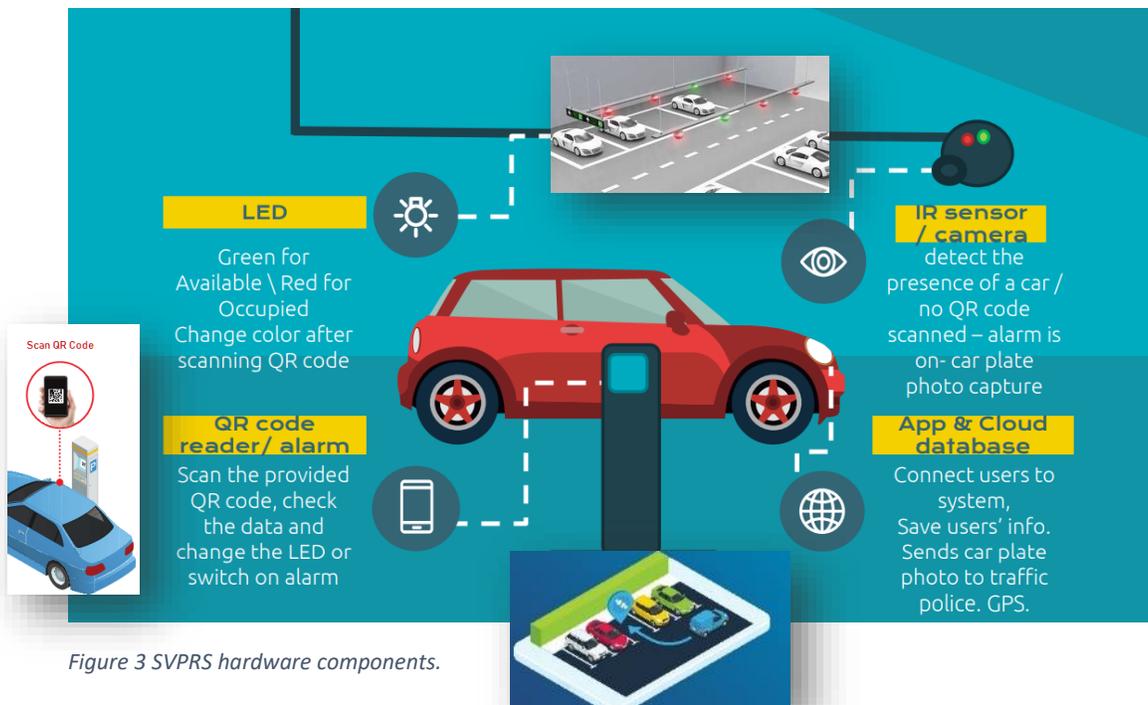
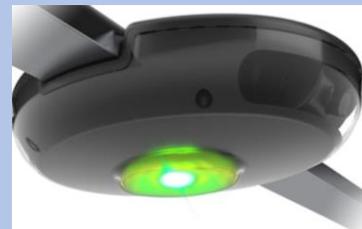


Figure 3 SVPRS hardware components.

Hardware components:	Description:
Camera-based occupancy detector & car plate recognition	A camera-based detector is a smart-sensor i.e., it contains a processor that perform the functions of plate recognition and LEDs switching, process and exchange data by itself, battery backup to help in case of power outage and a live security video.



QR code reader	Long range QR code reader attached to each parking lot.	
Alert/ alarming sys.	Attached with the QR code reader. The alarm will be switched on in case of failure of providing the right QR code of the reserved parking lot. It could alert the user either he/she are in the wrong parking lot or the QR code is not the right one for this lot.	

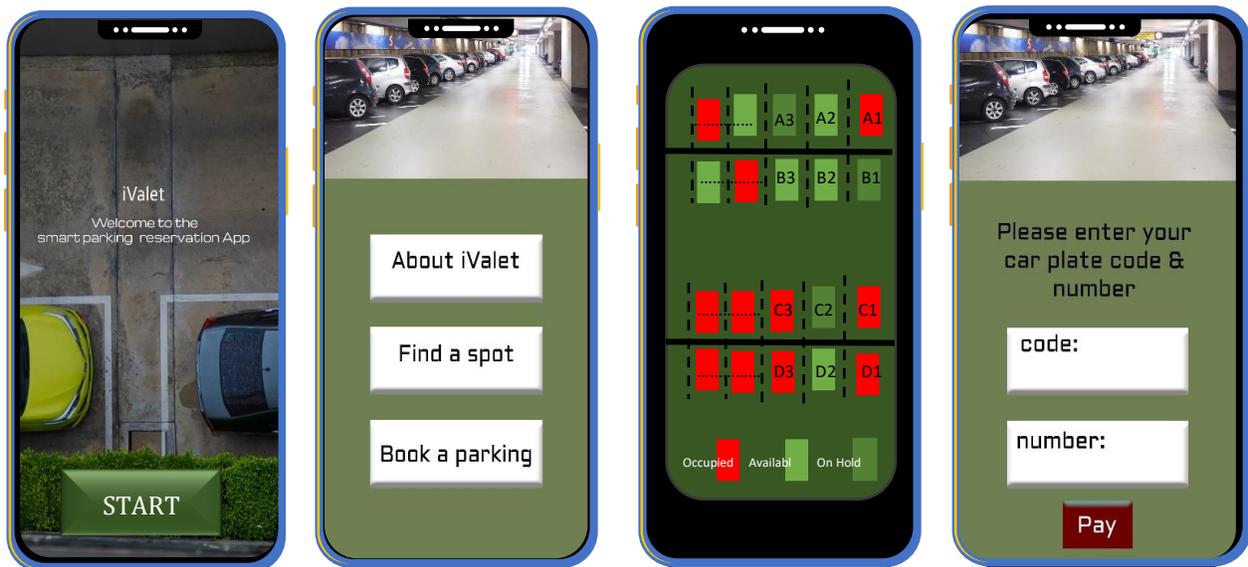
Table 1 iValet Hardware components

3.2 Software

Software structure:	Description:
Wi-Fi -Internet	A Wi-Fi network is required to allow the smart equipment to communicate using the IoT technology.
Cloud based database	Replacing the current servers that are expensive and requires a place to be fixed in, the cloud-based servers could carry on more data and allow data exchange through the internet.
Smartphone App.	<p>The smartphone application will be called “iValet”, it will connect the hardware operations with the logical operation to provide all the information of the car parking lot status, the prices and fees. The needed features to be added in the application by the App developing company are listed below:</p> <ol style="list-style-type: none"> 1- Searching feature to search all the places that have iValet service. 2- Booking feature, showing all the available parking lots, booking the parking lot by the car type & plate number with the phone number of the driver and could hold the parking for a user until confirmation. 3- GPS feature to guide the driver to the reserved parking lot exact location, also to guide him/her back to the car location. 4- Payment/refunding feature with different options, credit card or Apple Pay. 5- QR code generator 6- Push notification feature that will notify the driver 10 minutes before the end of the waiting time. 7- Waiting list feature where the driver can put a note on the preferred occupied parking and get a notification when its available.

Table 2 iValet Software structure

In table (2) the needed software structure is described and figure (4) is showing iValet application interface, the user will start by pressing the start button to get into the second step page where he/she could know more about iValet and how it works by pressing the first button, then the user can use the second button to search all the possible parking spots that provide iValet services with in-app searching feature. Next, the user can press the ‘Book a parking button’ to access to the real time data of destination parking lots with all available and occupied spots. After choosing the desired spot the user will need to enter his car plate code and number, the chosen spot will be ‘on hold’ until he proceeds to payment. The user has the choice to choose one of a three cashless payment methods i.e. Apple pay, debit or credit card or Paypal. Finally, the app will generate a unique QR code for the parking lot reservation and display it on the user’s phone screen. In case of closing the app before screen capturing or scanning the QR code, the user can call or contact the customer service where they will ask to provide them with the car plate information and receipt to get a new valid QR code for the reserved parking lot.



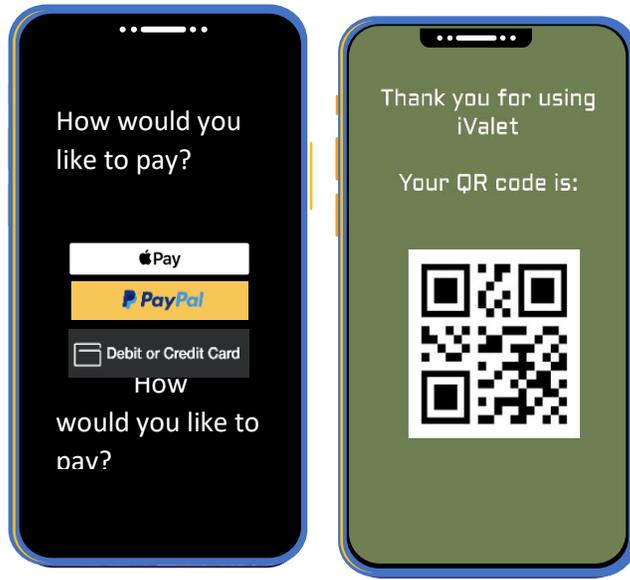


Figure 5 iValet smartphone app. interface sample

Figure 6 iValet smartphone app. interface sample

Chapter 4 Business Model Canvas

In this chapter, the business model canvas is explained below:

Value Proposition:

iValet is a project that combines different technologies such as IoT and the cloud computing so a customer can benefit from both a smart parking solution for the congested parking lots and a car valet service to reserve a safe parking spot in a few and easy quick steps with minimum fuel usage. It needs to keep the customer to feel comfortable while using the valet parking service with minimizing the time spent on searching for a parking lot using the smart phone prior arrival and facilitating the payment (online).

Key Activities:

iValet is providing an online service for the car parking valet companies which help customers, who are not willing to let any stranger to park their vehicles, to reserve a safe parking spot for their car in their future destination and also an online cashless payment feature. Of course, to maintain a good quality of the services provided, a frequent maintenance is required by the company for the whole system.

Key Resources:

To keep the business running, iValet needs to have a good space of parking lots either in an open or enclosed area to install the hardware components such as sensors, objective detector and the alarm. A cloud-based server for saving and exchanging of data between users and parking lots.

Customer Segment:

The project is targeting all possible users of iValet from car owners and those who stopped using the car valet services due to the social distancing concerns, and all possible buyers of parking system vendors, car parking valet companies and the Road and transport Authority (RTA).

Customer Relationships:

iValet values customer time and opinion so there will be a customer service and call center for quick inquiries and problem solving.

Key Partners:

The key partners of iValet are those who are involved in developing the project activity like App developers, software and hardware suppliers, parking spaces vendors and not neglecting the Road and Transport Authority (RTA) and Dubai Police role in authorization and process organization.

Channels:

iValet will communicate with its customer over the smartphone app which will connect the system of the parking lots directly to them providing the information of the vacant spots and allow them to reserve and pay online. The App will save the user's data for the reserved spot after the payment is confirmed and then will generate and show a QR code to the user as a confirmation message.

Cost structure:

The possible cost structure of iValet would be for the HR salary, area rental, marketing and IT backend expenses e.g., App development and maintenance, and for software of data acquisition

and cloud-based server. Sourcing through key partners will reduce in the total costs of hardware suppling and App and software development and maintenance.

Revenue Streams:

The project revenue streams could be from the service provided i.e., reservation fees, fines as a service fee, and from the advertisements on banners and in-app Ads.

Chapter 5 Conclusion

5.1 Conclusion

In conclusion, the idea of replacing the current car parking valet service with a smart pre-reservation parking lot online arise after the pandemic of covid-19 which encouraged people to use private cars and to help with social distancing. The smart valet parking reservation system will increase customers happiness by allowing them to get the valet services benefits e.g., knowing exactly where to park the car as a pre-reserved spot, and usually it will be near the entrance, but without the need of giving the valet guy to park it, instead the driver will use his smartphone to search for a spot, reserve it and pay online in advance with an efficient system software. Also, the driver could follow the map to reach the reserved parking lot and to return back to the parked car with the GPS feature. The Cyber-physical systems, IoT technologies will ease the procedure to drivers and the service providers i.e. valet service owners, and will allow the government to get connected to reach to the real data and to take any action needed in case of parking policies violation by drivers. However, it will be a good solution for the people who admires smart technology and are interested in the self car parking valet services and for those who value time, health and our globe status, in addition to that, valet parking service companies will reduce in-site

workers instead, they will need only customer service employee and IT technician, where they will enjoy the long term revenues. This paper is introducing a new concept of car parking valet service, a solution that would be a good contribution in dealing with future pandemics, it is most suitable for enclosed parking areas which is already equipped with smart parking components like the objective detectors and vacancy status LEDs.

5.2 Future Work

As per the possibility to implement this project in real time, the implementation is requiring a generous grant from RIT or RTA or any other entity. The budget estimation is as follows: 1- Additional hardware equipment to current parking lots: o QR reader with alarm/ parking lot: 570 AED (the prices vary upon quantity) 2- Cloud based Server: depends on the data transferred, but BigQuery service from google cloud provide flat rate of monthly paid service of: 7420 AED 3- Native or hybrid phone application: 50,000 AED – 150,000 AED

Bibliography

- Kotb, A., Shen, Y.-c., & Huang, Y. (2017, April 19). *Smart Parking Guidance, Monitoring and Reservations: A Review*. Retrieved June 18, 2021, from IEEE:
https://ieeexplore.ieee.org/abstract/document/7904775?casa_token=yGp-VVgV_XYAAAAA:wuPqLB6sF3sLpjyUNRCpENhtLyXdYdGdM2h9YM8fL6z2RK4Eyb2VeAc7UOYK4CHOrm-CYCIX
- ELKHALIDI, N., BENABBOU, F., & SAEL, N. (2020, Oct 3). *Survey of Reservation Techniques in Smart Parking*. (IEEE) doi:10.1109/ICSSD47982.2019.9003165
- Lin, J., Wang, J., & Chen, G. (2020, Feb 13). *A Novel Reservation Approach for Smart Parking System*. Retrieved July 2, 2021, from IEEE: <https://ieeexplore-ieee-org.ezproxy.rit.edu/document/8991735>
- Zheng, P., Xu, X., & Chen, C.-H. (2018). A data-driven cyber-physical approach for personalised smart. *Journal of Intelligent Manufacturing*. Retrieved from <https://link.springer.com/article/10.1007%2Fs10845-018-1430-y>
- AMOL, M. (2019, Nov 28). *United States Patent No. US2019362457 (A1)*.
- Boudali, I., & Ben Ouada, M. (2017). Smart Parking Reservation System Based on. *Applied Artificial Intelligence*, 31(5-6), 518-537. Retrieved from <https://www.tandfonline.com/doi/full/10.1080/08839514.2017.1378275>
- Cole, G. (2019, Nov 26). *What Students Should Know About the Cities of the Future*. (Keystone master studies) Retrieved 2021, from <https://www.masterstudies.com/article/what-students-should-know-about-the-cities-of-the-future/>
- Coronavirus disease (COVID-19) advice for the public*. (n.d.). (World Health Organization) Retrieved June 29, 2021, from <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public>
- Hainalkar, G. N., & Vanjale, M. S. (2017). Smart parking system with pre & post reservation, billing and traffic app. *International Conference on Intelligent Computing and Control Systems*. IEEE. Retrieved June 22, 2021
- Hassoune, K., Dachry, W., Moutaouakkil, F., & Medromi, H. (2016, Oct 20). *Smart parking systems: A survey*. Retrieved June 20, 2021, from IEEE:
https://ieeexplore.ieee.org/abstract/document/7772297?casa_token=7HrfMVX7E6YAAAAA:5oTa357cM68wipvJwPf4dr3LUuedfar32OEjkVN6e_7iHLQ-j-beTFng_uE87NgKrWPwo9Fa
- Hoq, E., Paul, S., & Tariq Ur Rahman, M. E. (2019). Development of QR-code Based Smart Car Parking System. *5th International Conference on Advances in Electrical Engineering (ICAEE)* (pp. 275-279). Dhaka, Bangladesh: IEEE Xplore.
- McCoy, K. (2017, Jul 12). *Drivers spend an average of 17 hours a year searching for parking spots*. (USA TODAY) Retrieved July 10, 2021, from

<https://www.usatoday.com/story/money/2017/07/12/parking-pain-causes-financial-and-personal-strain/467637001/>

- Pham, T. N., Tsai, M.-F., Nguyen, D. B., Dow, C.-R., & Deng, D.-J. (2015, Sep. 9). *A Cloud-Based Smart-Parking System Based on Internet-of-Things Technologies*. Retrieved June 20, 2021, from IEEE: <https://ieeexplore.ieee.org/abstract/document/7247632>
- Safitri, R. R., Pratiarso, A., & Zainudin, A. a. (2020, Nov 20). *Mobile-based Smart Parking Reservation System with Rate Display Occupancy Using Heuristic Algorithm and Haversine Formula*. Retrieved June 23, 2021
- Sifuentes, E., Casas, O., & Pallas-Areny, R. (2011). Wireless Magnetic Sensor Node for Vehicle Detection With Optical Wake-Up. *IEEE SENSORS JOURNAL*, 11(8), 1669-1676.
- Tesorero, A. (2018, May 5). *Dubai has so many cars, but what about parking spaces?* (Khaleej Times Dubai) Retrieved July 10, 2021, from <https://www.khaleejtimes.com/nation/dubai/dubai-has-so-many-cars-but-what-about-parking-spaces-free>
- Vos, J. D. (2020, May 10). *The effect of COVID-19 and subsequent social distancing on travel behavior*. (Elsevier) Retrieved June 29, 2021, from <https://www.sciencedirect.com/science/article/pii/S2590198220300324>
- Wang, H., & He, W. (2011). *A Reservation-based Smart Parking System*. doi:978-1-4577-0248-8
- Workplace Safety Related to the COVID-19 Pandemic*. (2020, June). (Valet Park of America) Retrieved July 10, 2021, from <https://nantucket-ma.gov/DocumentCenter/View/36712/Valet-Parking-Safety-Measures-Related-to-Covid-19-Pandemic-PDF>