

ParkOset - An Intelligent and Sustainable Car Parking Management System towards Solving Traffic Congestion Problem in Developing Countries

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Abstract

It has been observed that rapidly increasing urbanization causes tremendous traffic congestion which is a threat to the developing nations welfare in terms of their economy, growth and social-integration. Apparently, among the various reasons, an adequate car parking management can reduce traffic obstruction, unpredictable accidents, pollution as well as carbon emission. Various studies indicate that around 30% of the traffic congestion in the urban cities is caused by inadequate parking system. Oftentimes drivers struggle to find adequate parking space and as a result tend to park their vehicles adjacent to the main roads. Although some private institutions bound drivers to park with their personal initiatives, yet people find it difficult and look for a solution that could lead them to free in/out-bound parking venue. This paper proposes an efficient and sustainable mobile application-based solution towards solving traffic congestion problem in developing countries contrary to traditional parking systems which are based on GPS, RFID or Sensors while maintaining sufficient accuracy. The proposed solution intends to eradicate the time-consuming dilemma of free and paid parking by giving access and pre-bookings to the nearest parking space on-forth, enabling unwavering smart cloud-based parking solution with tangible and intangible economic benefits for the developing countries.

Keywords: Intelligent Car Parking; Smart Parking Management System; Traffic Congestion; Sustainable Solution.

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1. Introduction

A good transportation system is central to every nation's wellbeing. Most of the developing countries are facing problems with the rising trend of urbanization where people from the rural areas migrating to urban areas for seeking opportunity for a better life. On the other hand, with the rapid growth of economy and investment on personal wellbeing, everyone wishes to have a private vehicle to ease his transportation. As a result, in addition to the negative impact on the environment, city traffic congestions have also increased a lot, including demand on parking setups accessible to the general mass.

A study on human parking behavior shows that 63% people spend more than 10 minutes searching

for a vacant parking spot [3, 39] which is the cause for 30% traffic congestion in the urban areas that results in time wastage and environmental threat to the overall development of a nation [8]. In reaching a parking lot, drivers generally tend to park illegally which is about 55% on main roads and only 17% only to the nearest parking. [39]. These major percentages of people cause traffic congestion unintentionally due to a lack of parking management and adequate guidance. Researching on a developing country such as in Egypt, World Bank reveals that in Cairo Metropolitan Area (GCMA) with a population of 19.6 million, 4% of total GDP lost due to congestion which is

USD 6.5 billion [10]. So, this loss could be added to the wellbeing in the driven economy if this traffic

problem eradicated. The driver often gets perplexed in search of free parking space especially in inbound (private/institutional/paid) parking which is 2% of the total parking space compared to outbound public parking [44]. So, if these drivers are directed to outbound parking then congestion and difficulties could be in check. Police report shows that yearly 19-25 vehicles in China have been stolen [17]. Due to advanced technology, some hackers could unlock automated cars by penetrating their access keys from roadside illegal parking [17, 22] which indicates the security measures to be conveyed to the general mass for such act [33]. So, from the above explanation, it can be stated that the proposed new parking management system is of critical importance to all developing countries.

Although exorbitant amount of research works exists in the area of design and development of intelligent parking management system (IPMS) neither could depict the socio-economic perspectives in terms of the sustainable cloud-based, real-time navigation within the parking facility in developing countries. Thus, the objectives of this paper are as follows:

- To further analyze the real influence of the parking management system based on practical studies and outcomes on socio-economic perspectives.
- To examine the contemporary features on the mobile application in recent publications and how proposed mobile application (ParkOset) can delivers unique statures.
- To design a user-friendly interface basing on the core values of human computing interactions based on cloud.

Advancement in technologies has inaugurated various avenues in the car parking management system, previously car parking system only brooks the parking availability on the spot and inbound parking venues. However, due to myriad parking demands the traditional system fails to keep the track of availability on the other hand drivers face difficulties due to inadequate direction where exactly to park. Since almost everyone using a

smartphone in a contemporary moment thus, to direct the drivers via mobile application is considered as a viable option to mitigate this critical problem. Consequently, cloud computing is also recognized as a reliable means to integrate with the mobile application to minimize the cost and increase the productivity in terms of accessibility, cybersecurity, and maintenance. Therefore, this ParkOset mobile application prefers to be integrated with the cloud platform and that will enable the users (drivers) get rid of all the difficulties, also would help the city smooth transition to its core development. For instance, during rush hours, especially when people rushing back to their home or any nearby events to look up for the parking in the events such as Football, Cricket or Basketball etcetera. They are not aware of the roads and traffic density thus this system would allow users to direct them to the fastest route to reach their destination and book their parking space in forth. The system would have special quota for disable people to get the best parking and booking for the spot for a bit longer so that the disabled people do not intend to park illegally at any events with secured payment statures.

In this paper, an interactive mobile cloud-based intelligent parking management system (ParkOset) is proposed. Where the paper is organized as follows: Section II contains a literature review, section III presents the methodology, section IV shows the analysis, in section V the system model is illustrated, and section VI elaborates the conclusion and our future enhancements.

2. Literature Review

This paper is about the services, offering potential parking arrangements for their private vehicles to park in forth. Therefore, the Convention-Centers, National Stadiums, Shopping malls both private and public are the main customers. In Asian developing countries have a lot of issues with traffic congestions, as in progress of developing countries such as Malaysia, Pakistan, India, Bangladesh needs this problem to eradicate to upholds their respective countries. Since this mobile application would give service for free to end-users for public parking. For

“ParkOset” the main revenue would generate from the parking spot owners”

In this review, it delivers a full-fledged state of the current parking management in the developing countries and acquired critical knowledge in order to demonstrate how current major problems and issues in the researched area can be mitigated via the proposed application. Foremost while starting the review of literature, it is a vital point to identify keywords, potential issues of the sources [5].

In the following study the paper would show, domain and technical research on previously published work on similar systems to explicate the impact factor for the proposed IPMS.

A. Domain Research:

According to the Victoria transport policy institute, Parking is an important component of the regular transportation system. Vehicles should be parked at every location in order to pick-up and drop-off passenger including drivers. A typical automobile is parked 18 hours each day in On-Street and Off-Street [27] uses several parking spaces each week. Lack of convenience affects the ease of reaching destinations and which affects the overall accessibility of the entire road. In a word, the management of parking to maintain various policies and programs that result in more efficient use of parking resources. Parking facilities are a major cost to society, and parking conflicts are among the most common problems facing designers, operators, planners, and other officials [27], thus the socio-economy is hampered for lack of proper management.

Current Parking Management offers a system that is designed and developed from ‘on/off-street’ parking allowing the minimum security and reliability, with complete access to data management in the computers of the respective parking management team. Besides providing access to controlled parking areas, these systems comprise parking sensors, gateways, revenue management, and central software for administrative reporting and analytics. Figure 1 shows a typical infrastructure of the current parking management system in developing countries.

Moreover, In the developing countries, the parking management system is not fully automated, drivers have to issue token once they enter to any premises without knowing where exactly to park their vehicle and while leaving, they need to pay in the pay-stations.



Figure 1. Typical Parking Management (Off-Street and On-Street) System in Developing Countries [31]

In Fig. 1, the current parking management has been illustrated for a vehicle when it comes to off-street parking where drivers usually take a token from a token dispenser without knowing the specific location to park their car. On the other hand, talking about the technological sides, once the driver takes the token, immediately the main parking management system gets a notification as the issued token contains an RFID chip [7, 27]. However, in the current parking management system, there are a lot of flaws that can be modified as per the user convenience in the ParkOset, giving access to parking availability in forth, payments and directions. With certainly parking is one of the most daily basis difficulties both developed, developing countries. Every day thousands of corporates rush towards their workplace, students to their shops. Furthermore, the raw materials from the shipping ports to urban destinations that hold the highest significant [29] in the country’s economy hinder smooth transportation. According to statistics in the USA (developed) despite having 1.3:1 people to cars compared to China (developing) 6.75:1 ratio they have less congestion, it is because compared to USA urbanization rate of China is 56% [4] so developing countries like China, Malaysia, India, Bangladesh, Pakistan having this intangible problem. Where parking is a potential threat to the country’s

growth where we need to focus. Since for seeking opportunity and with the progress of developing the nation people focus on the urban cities, so it is now critical importance for a convenient parking management system that is missing from the current statures.

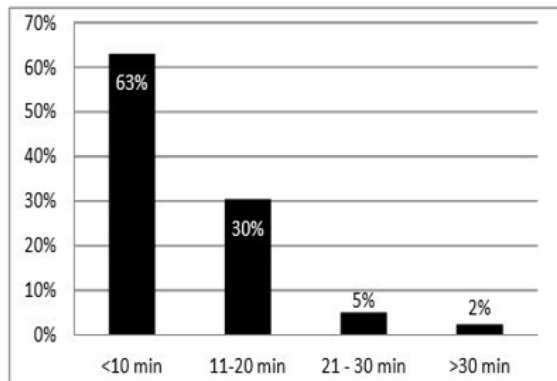


Figure 2. Time Spending while Searching for Parking Spot.

High densities of the cities increase of car dependency and for economic transition are on the same path, so challenges of parking are on peak, research shows on “Chania” in Greece that 63% people spend more than 10 mins searching for vacant parking [2] above survey shows on average 15 minutes is required. These few minutes might not seem significant, but the impact factor is tremendous according to [10] if USD 6.5 Billion dearth in national GDP each year for the transportation system then with some calculation we can find the traffic congestion cost USD 12.5 thousand per minute [17].

So, with the help of ParkOSet this problem can be solved. Recognizing the way of the solution to solve this issue for parking in Abu Dhabi inbound parking automated system has been made in Dubai [46] to eradicate the hassle of searching cars in Burj Khalifa is successful unless the payment gateway for the drivers made manual due to server failure. Whereby it can be observed the importance of the reliable parking management system because relying on the servers which were not on cloud, could be failed due to unavoidable circumstances and needs periodical maintenance and human scrutiny. Lately with the Price Engine, Sensors, Data Centre in United Kingdom student proposed for Manchester

University car parking system which is convenient for students with the help of the student ID they are able to park according to the allocated place they are given [16]. This research inaugurating the possibility of implementing such a system in developing countries via their smart citizen ID which a form of RFID. Apparently, this technique can be easily implemented with smart voter identification card for example in Malaysia, Bangladesh also in Pakistan [47,48] (developing) local citizens have smart IC where they can reload and can use as touch and go purposes for paying trains, buses such processes in a word, a one-stop services using this payment gateway collaborating with the mobile application the system can make effective in context of the paid parking or free parking preferences of the users without the hassle of RFID and using only ParkOSet.

Talking about the technological side of this IPMS, new business model for parking services can be made with the help of mobile application via cloud solution like Amazon, IBM, Microsoft or Google cloud platform where they have integrated e-commerce for secure business transactions [13, 45]. Therefore, in a smart parking management system, a mobile application can be connected to the cloud servers to fetch data for parking spots provided by the customers (venues parking providers, for inbound parking). Hence, for parking service, both end consumers (car drivers) and parking service providers can use this. With the cloud solution, it refers to the backend service provider where for the consumers it will track user activity request preferred location [6] In the following graph the demographics of using a smartphone is shown as means of a viable option for the parking management system.

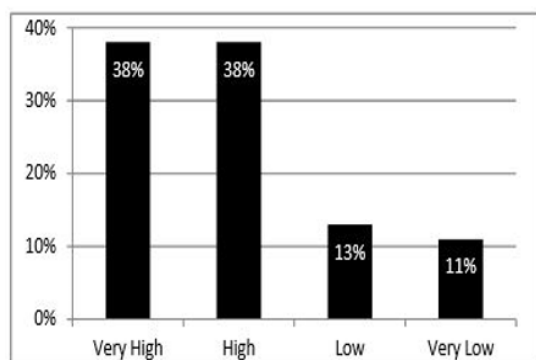


Figure 3. Uses of Smartphone for Navigation.

In the above figure 3 [6] researcher of Harvard University while surveying for the inbound car parking system among 40% of total student those using the private vehicle 38% of them tends to use smartphone application for getting the availability of the information [6]. This shows 96% among the total sample size which is shown the figure 3 [24], so inaugurating of this proposed system can get the positive response upfront. Moreover, backend for the on-demand service-oriented system is the fundamental thing [1] taking the concept for this parking management users would be referred to locations basing on the cloud solution where the backend management crew is not responsible for server interrupt, which would strengthen this application. For the information system, everything would be connected in the cloud for both ends once the user request for the parking, the mobile application would give the drivers the exact spot for the parking. Therefore, the adaptability for the new technological system is much more promising in the proposed mobile application. Thus, the model of the cloud-based design for the mobile application whereby, the smooth and promising parking system is mentioned [11] in the following illustration the cloud-based mobile application.

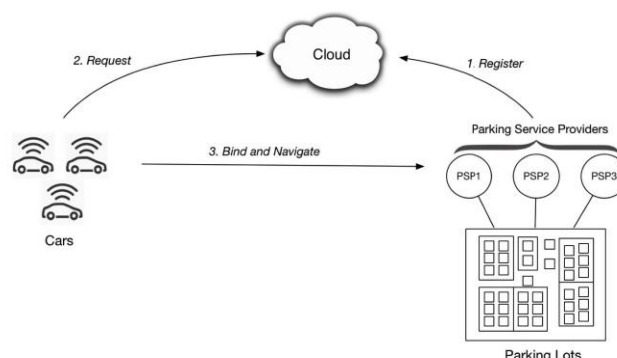


Figure 4. Cloud Infrastructure for Parking Management [24]

Figure 4 shows how the registered drivers request for available parking through the cloud server and instantly find the vacant lot to park. This technique is successfully implemented in China at Beijing International Airport (regarded as one of the world's busiest airports [17]) where the parking can be chosen easily and efficiently. Hence the viability of IPMS with proposed ParkOset mobile application with cloud-based infrastructure can bring success to mitigate the agonizing parking congestion problems in the developing countries.

B. Technical Research

Technical research helps to recognize similar products that exist in the recent market, their functionalities and system infrastructure [49].

Developed countries, with growing traffic congestion in urban areas, have also introduced some mobile app based services to address these problems. Below are some of the similar systems that are currently available in the market. The following points describe the similar systems compared to proposed "ParkOset" in detail in light of their functionality and application process model. This comparison will help to analyze the limitations, constraints and strengths of similar applications.

• Parkmobile LLC:

Parkmobile is a private company that is one of the leading providers for on-demand and prepaid mobile payments for on- and off-street parking. Their services have been adopted in more than 2,000 locations, including 39 of the top 100 cities in the U.S [53] with potential millions of users.

Parkmobile's services include on-street parking, off-street parking deck, airport and event reservations, and public parking permit solutions.

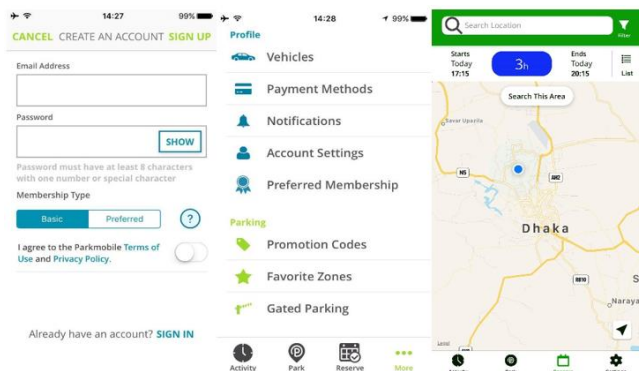


Figure 5. Parkmobile's Application UX [53]

Fig. 5 shows how "Parkmobile" application provides service to the users through a mobile application. Starting with accessing users' current location, this application does require mandatory sign up first. After validating with the credentials they provide suitable locations from their application server without being asked for payment.

The following figure would clarify the application process model:

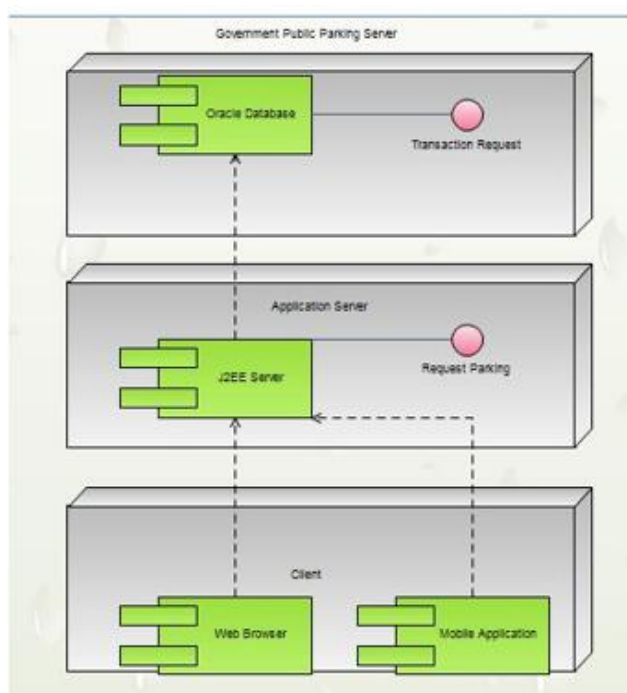


Figure 6. Parkmobile's Application Infrastructure [53]

Fig. 6 shows in detail how exactly the "Parkmobile" provide its service. It can be observed that a client can book or reserve the parking spot by means of two ways via web browser and by their mobile application. The request directly goes to their application server and secure a parking spot. Later by peer connection with the government server, application asks for the payment.

• Spot Hero Inc:

Spot hero is a North American parking reservation service provider that connects users to prepay and reserves parking spaces for them. Since 2011, when this mobile application launched, it could cover all states of the United States [14].

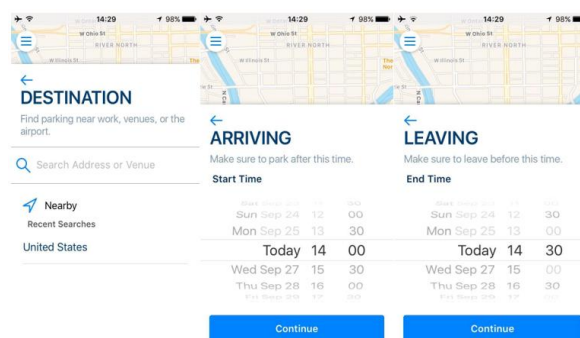


Figure 7. Spot Hero's Application UX [14]

Figure 7 shows how "Spot Hero" mobile application works starting from the booking spot and approximate time to arrive and leave the destination. This refers that a user has to go through a contract soon as he/she login or sign up for it then the application retrieves the information from the server (application) showing the available spot and gets the parking service. In addition to that service, users can also check the status of their e-wallet and if they want to pay by card using a smartphone. The following figure would show the process of the application.

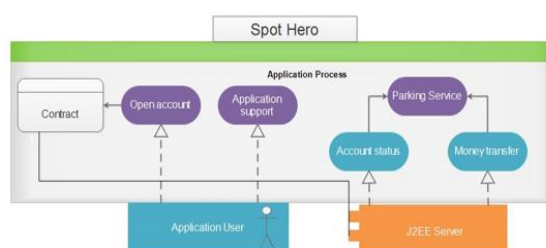


Figure 8. Spot Hero's Application Infrastructure [14]

Figure 8 shows the application process of the Spot Hero which exhibits its workflow starting from the user's end. It requests user for a contract giving the proximate time and location for destination. From the request, it retrieves the parking spot whereby users can see their account status and option of their payments to secure that parking. However, in the following section, the personal reflection of the researcher has been given comparing the proposed mobile application, which is being designed and as a viable option for developing countries to adapt and for sustainable application to mitigate the traffic congestion.

In the table (I) in comparisons to the similar systems to the proposed mobile application, the following table would identify precisely how ParkOset would stand out in the IPMS avenue in the developing countries, by providing viable implementation than an existing application which is being developed for the first world countries.

Table I. Parkmobile, SpotHero & ParkOset Comparison.

Applications Issues	Parkmobile	SpotHero	ParkOset (Proposed Application)
Usability	From usability point of view, Parkmobile holds some issues such as mandatory registration, payment method selection and prepaid system, which can sometimes	SpotHero is offering a good transition of the user service flow [15]. It secures parking and alert users unless externally it has been requested for the payment.	Due to backend cloud computing infrastructure, this system is simpler than both. Above all the usability has been proposed as 3 steps to functionality like Uber [55], whereas user can

	transforms into lack of usability [15]		accomplish his/her task within 3 taps on the smartphone.
Simplicity	According to the users' opinion, it's a bit complicated.	It is simpler than the Parkmobile, yet simpler design can be made.	It has been proposed for implicit simplicity as per user experience (UX) design
Cost Effectiveness	Take charges while using this service	Additional charges have been assigned as per location and demand	Totally free service; no burden of payments except on user demands for paid parking.
System Architecture	Application servers are used for spotting secure parking from the database.	Similar to SpotHero, it retrieves information from application servers.	Cloud model PaaS has been chosen for the system core architecture.

In the table (I) to a similar system to the proposed mobile application, the following table would identify precisely how ParkOset would stand out in the IPMS avenue in the developing countries, by providing viable implementation than an existing application which is being developed for the first world countries.

In the domain research, the importance of parking management software to the growth and success of the developing countries compared to developed countries has been identified. It has also been noted that the impact of IT and IS in the development and expansion of urbanization is significant, and one of the areas it can impact was a systematic approach in car parking management processes. Consequently, in technical research, user interface and human-computer interaction, factors have been

identified as important aspects of the success of the mobile application there have been discussions and analysis of two similar application. Although both mobile applications enable automatization in car parking management. However, they differ in cores in terms of operability, coverage and targeted markets in terms of developing countries. Therefore, in the proposed application based on developing countries statures, these aspects have been taken into consideration by the research.

3. Methodology

In the process of developing an IS (Information System), an adequate system methodology is being used which is a framework that is configured to structure plan and control the process of the overall development. Among the different methodology there are a lot of high standard methodologies for mobile application developments such as RAD (Rapid Action Development), Scrum, XP (Extreme Programming), DSDM (Dynamic System Developing Method) and UP (Unified Process). These all fall under the agile methodology [23]. However, the researcher has decided XP and DSDM to be most suitable for developing this prototype. Furthermore, the description and justification would be described.

C. XP (Extreme Programming)

Extreme Programming is an organized way of software development which simplifies the project communication, giving quick feedback which encourages the team to move towards the final goal. It combines the developing teams to review the system at agreed checkpoints where new user requirements can be added easily [34]. It also includes a flat management structure and accepts expected changes in the requirements as the time passes and the problems are understood deeper, as well as supports frequent communication between end-users and developers [35]. Since this prototype needs to develop for the developing countries, based on user experience (UX), developers need to enhance the application for successful deployment. In Figure 8, lifecycle of XP methodology is illustrated.

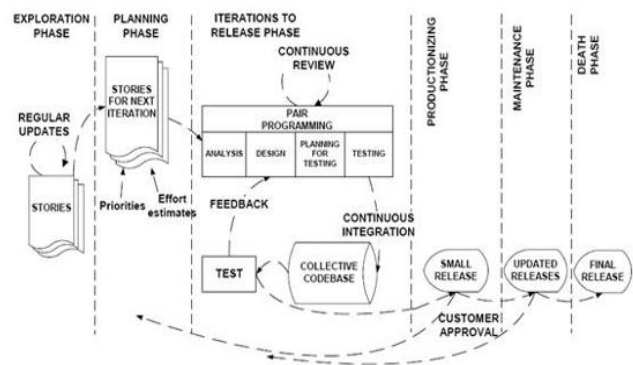


Figure 8. Life Cycle of XP Methodology [34]

Fig. 8 shows how summation of cumulative phases resemble XP, whereas, each phase required continuous feedback from the users' end rather than a linear model of planning, analyzing and designing which other agile methodologies offer. Moreover, it shows the ability to resilience and easy adaption of changes in the process. Thus, it encourages take problems proactively to solve them instantly along with the developments.

As it has been discussed that, for IPMS in developing countries require a lot of effort to understand the UX and develop the mobile application accordingly, among other methodologies XP is considered one the prior due to its proactive response and resilience stature.

D. DSDM (Dynamic System Development Methods)

DSDM is also an agile project delivery framework includes all the necessary guidance including optional deliverables required compliance, which focuses more on the outcomes without compromising the quality of the project and its management. Due to its continuous user involvement and agility designed for responsive projects, it can be implemented almost any project in a cost-effective way especially focused on services [37, 54]. Thus, this IPMS project where IT infrastructure could be inviable or truncate [16] (due to developing countries condition) in some instance, this methodology is considered by the researcher along with XP in order to justify which might be the most suitable for ParkOset development process.

However, in the following figure, lifecycle of the DSDM is illustrated below:

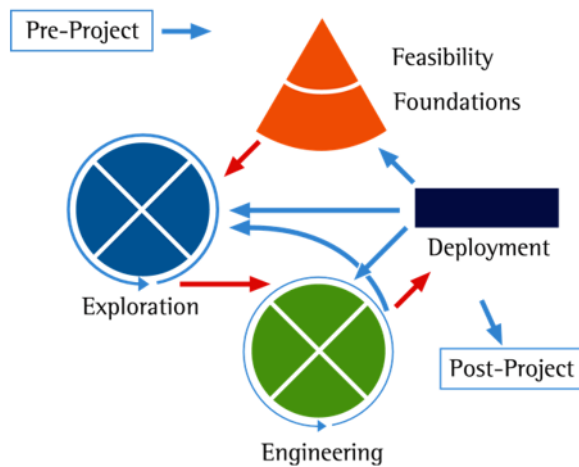


Figure 9. Lifecycle of DSDM Methodology.

In figure 9 [54] depicts that the DSDM process consists of a few phases within the lifecycle to deliver an IS, which are a feasibility study, exploration (business study), engineering (functional model iteration, design, build iteration), and deployment (implementation). However, the first two phases can be done at once and the rest three are iterative and incremental, any iteration must be completed in a fixed time. This fixed time is called a time box [54]. Lastly, the post-project which ensures the periodical maintenance which leads this methodology as reliable methods to implement for IPMS.

However, the justification is discussed below between XP and DSDM for sustainable deliverables for the developing countries perspectives.

E. Justification

Although, the researcher has chosen two most suitable methodologies and discussed above for the cloud-based IPMS, however, due to post-project leads in the DSDM approaches potentially hinders the criteria if customers are geographically distributed for instance if any users come to visit the developing country for few days and want to get the parking facilities it could be hard to reach developers for improvements or interactions. Thus, XP can be justified for this development. the following table (II) would distinguish the core elements with merits and pitfalls.

Table: II. XP and DSDM Comparison.

	XP (Extreme Programing)	DSDM (Dynamic System Developing Method)
Merits	• XP is an iterative development method • Trusts the developer • Customer makes business decisions. • Continual process improvement. • Not tied to expensive tools. • Developer makes technical decisions. • Lightweight on process side.	• Risk is minimized up to highest extend due to it iterative and incremental nature. • The solution obtained fulfils the exact requirement of the user all the times. • System implementation goes in very smooth way.
Pitfalls	• Dose not specify artifact. • A lot of customer involvement. • Perceptions that it is organized hacking. • Does not have a lot of tools	• More user involvement can be danger some time if the user is not an appropriate individual. • User is considering as the owner of the solution • User is trained before the system implementation.

From the comparison table (2) it can be stated that focusing on the developing countries users for the IPMS, XP can be considered as a suitable and sustainable developing methodology. Since the major focus on the fastest response to the user's demand. Unlike DSDM development methodologies "time box", XP enables developers to do all the processes and activities of development

such as planning, analyzing and designing in less timeframe, which allows the fastest interaction with potential customers (parking management system) and follow respective changes inefficient way. Since it would be the first implementation of the new system in developing countries, it will require periodical improvements before handed over to the users. Moreover, among the pitfalls XP has a lot of customer involvement for general development, however, for this proposal, ParkOSet needs more customers (parking vendors) Thus, with a cloud-based solution developing such IPMS, XP has an additional advantage since it would rather appreciate more customer involvements. Therefore, should be considered the most suitable for the development.

4. System Architecture Analysis

The system architecture is a blue print of the system which includes conceptual model, behavior and more views of the system. Usually, with the adequate description of model denotes the entire system. However, by the system architecture, it supports the overall patterns of the system [12]. In this chapter, the prerequisite of the system implementation would be discussed by the researcher after primary and secondary which has been conducted. Thus, the system architecture which includes Use Case diagram and Activity Diagram. Moreover, to understand the system architecture precisely the core features of the system would be introduced.

To derive into the system architecture the researchers adhered to several interviews from experienced parking managers, software engineering's and taken a survey (via google forms), where more than hundreds of participants with various age range [fig.9] were from different developing countries (Pakistan:5%, India:15%, Bangladesh:15%, Malaysia: 40%, Other.

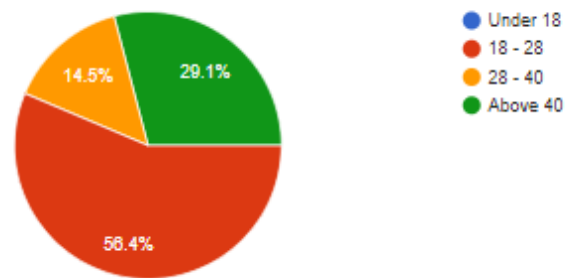


Figure 9. Survey Infographics 1(Age Groups)

Developing countries:25%) participated, which indicates the buttress for the problem statuses [fig.10]. Among the different suggestions in options as the key features' participant seems identified almost all option in their height (priority) such as for illegal parking with more than 70% upvote. Again, respondents chosen for public navigation missing on the road which is by 54%. On the other hand, searching for the parking people agreed by 45%.



Figure 10. Survey Infographics 2 (Supporting Cause)

However, the researcher derived the solution for socio-economic perspective how could they instill to users' adaptability towards this mobile application via interviewing respective experts relevant to PMS. Since in the developing countries especially in Asia, people tend to pay less [fig.11]. Therefore, in the proposed application any users can look up for parking vacancy and get direction without being register to the mobile application. This feature is completely new from the analysis including developed countries IPMS. This feature is proposed in this ParkOset IPMS and named "Incognito Mode"

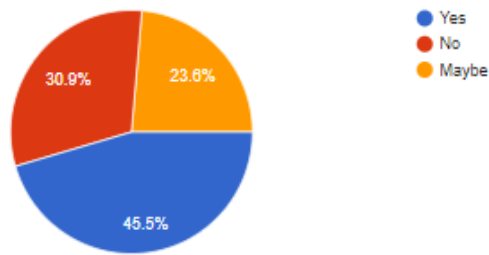


Figure 11. Survey Infographics 3 (Payments)

In figure 11 shows less than 50% of people agreed to pay via application rest denied and gave vague negation. However, researcher after interviewing management, engineering personals and came up with the decision which aligns with "Freemium Business Model"[15, 32] which indicates the viability and sustainability of the mobile application for the developing countries. For instance, a developed city (Palermo, Italy) in [32], the researcher proposes, the pricing scheme based on the traffic density in that city and made the pricing variable. Again, in [17] researcher used mathematical mixed-integer linear programming (MILP) to reduce monetary cost and maximize the parking manager's revenue based on queuing. However, proposed parkoset priority to reduce time since it is the main concern for developing countries. This will not justify the context of developing countries. On the contrary in developing countries this Parkoset is proposed to design such a way to give free access to lookup for the services so that at least people who tend to park in free parking allocation, get the navigation via "incognito mode" for securing the location further he/she then need to sign up to take the services. As a result of cumulative efforts, the overall process toward traffic congestion will be both time and cost-efficient in developing country's perspectives. Furthermore, in the proposed ParkOset applications Use Case, Work Flow Diagram and UX designing of the prototype is illustrated below.

F. Use Case Diagram

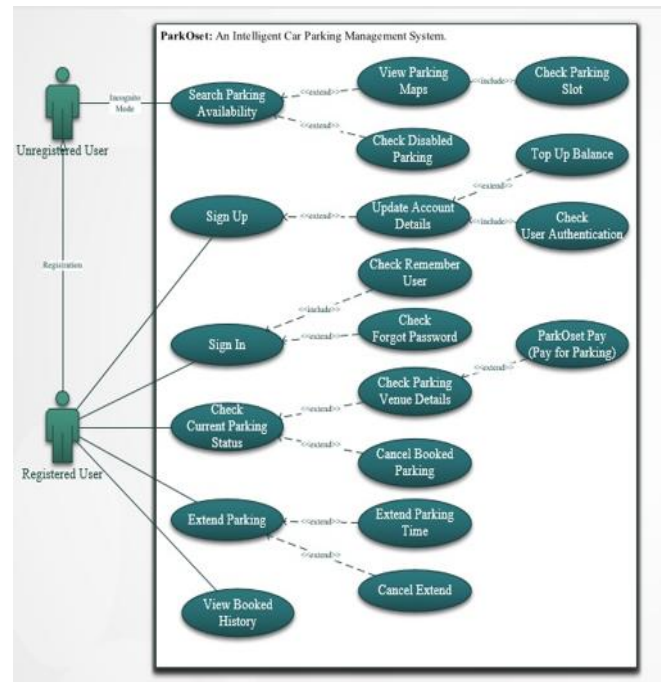


Figure 12. Use Case Diagram of ParkOset

In figure 12 it shows how use case of ParkOset differs from the traditional PMS [2] by implementing the incognito as per [20] it is illustrated the above description how users can get access to parking facilities based on usability and human computing interactions. Moreover, sustainable than [4,6] in terms of developing countries.

G. Work Flow Diagram

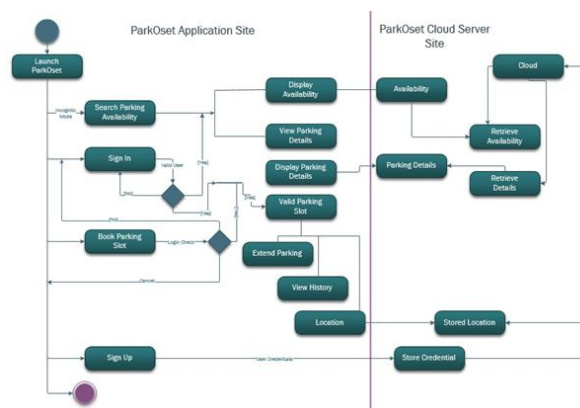


Figure 12. Work Flow Diagram

In figure 12 the workflow of the proposed ParkOset, IPMS designed as per Usability (speed, efficiency) and embedded HCI concepts so that, any

novice user can easily use the application and get the services. Starting from search parking availability which is shown a User can check the vacant spot and pricing which has been pre-stored in the cloud server by the parking authorities (managers). Previously, this function described as the “Incognito Mode” thus, the user can see the availability and reach the destination without putting any credentials into the application to mitigate the constraint. However, in order to confirm the venue user, needs to register to the system. While registering users can use biometric authentication as passcode as per [58] the speed and learnability of the secured system increase with a thumbprint or face-recognition (if any user device supports) by a significant amount of time. Which will validate directly from the cloud servers in real-time or embedded devices validations. Additionally, the extended parking slots feature is demonstrated to avoid any overtime parking to notify the users and in case a user crosses the allocated time in the parking venue he/she needs to extend the parking in order to avoid fine and most importantly to shun the perplexity of the system to direct other users to the same parking venue and increase compliance. On the other hand, in the cloud server along with the manual venue insertion, google API is proposed to have reliable traffic updates to the route which is integrated into the app, so that any user can get real-time updates to reach their respective destination with the fastest route.

H. UX Design

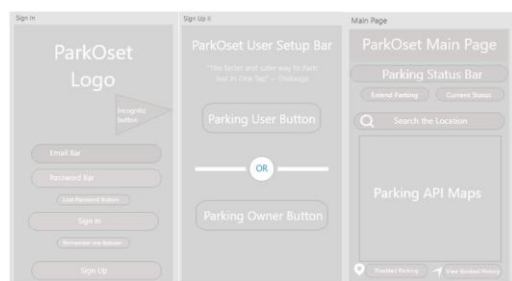


Figure 13. The User Experience (UX) Design

As per the previously illustrated use case and workflow diagram, this is the user experience design for the interface, as per usability concepts in

the top right corner “incognito button” is proposed for the client application so that the freemium model functionality is being served for the users. Consequently, the navigation page where maps kept at the center along with the necessary buttons in order to user’s other functionality is shown. At the top parking status bar and search for the location is situated and the bottom to priority spots for disabled is given. However, based on the UX design the prototype of the interface also made in the following figure it would illustrate for the sustainable IPMS.

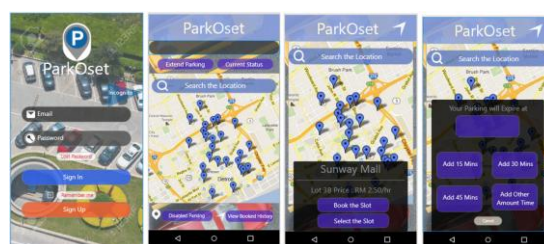


Figure 13. User Interface Design (Prototype)

In figure 13 it the prototype of the ParkOset is being illustrated, starting from the client's several usability tests. Here the navigation page would be using google maps API (application program interface) to display the real-time traffic status which would facilitate users to adept this mobile application on a large scale. Besides how users can extend parking slots in the dashboard with single tap functionality also being illustrated. Additionally, it is designed to build on the Android platform primarily, therefore, it will satiate the contemporary statures of developing countries users towards sustainable traffic congestion solution.

5. Conclusion

In a nutshell, this study explored the pertaining traffic congestion issue, how it is affecting the developing countries' progress and then proposed ParkOset: a sustainable solution via the mobile application which yields a dynamic real-time solution considering pollution impacts as well as economic perspectives of developing countries. The domain research has significantly influenced the authors to study the core subject and its subsidiaries along with the business cases to identify the challenges and practical difficulties for developing

countries. Additionally, it presented the empirical analysis of an eco-friendly cloud-based solution over the traditional parking management system. Moreover, system development methodologies are chosen according to the developing countries' deployment plans. This proposed system provides a cognitive walkthrough to make an efficient and learnable solution towards less educated users in order to mitigate the congestion. Thus an "incognito mode" based model is proposed which will enable radical changes in the design of the application and its usability studies. Even though the proposed framework mitigates traffic congestion at length, in order to make it more viable, secure transaction gateway and emergency extension of parking slot could be implemented via e-wallet. This research can serve as a basis for future scrutiny for the proposed new "incognito mode" techniques and frameworks.

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