Sustainable Web-based Car Park Booking and Staff Portal Management Information Systems for the New Muscat International Airport

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ABSTRACT
The unavailability of a dedicated website for the new Muscat International Airport has resulted in the unavailability of a web-based car park booking & management systems for the customers and a management information system for the staff of the new airport. A website including a car park booking & management systems and a staff web-portal management information system that are dedicated to the new airport are proposed and implemented. Based on the assumptions of availability of Automatic Number Plate Recognition, *e*-payment gateway and live flight validating systems, the website includes a web-based car park booking & management systems that are used to pre-book a car parking space for the customers with Omani license plate number vehicles. As an added feature, the system is designed to provide the nearest available car parking space to the customers whose flights are due and are in genuine need of a parking space. The staff web-portal is developed to manage the business resources and the processes of the airport including the car parks and its customers. Rapid application development methodology and tools have been used to develop the website and the staff web-portal with custom development for the web-based car park booking system. The website and its web-based car park booking & management systems have shown up-to 70% interest and success among the customers of the airport with comments and suggestions to add more features such as modifying booking dates and times in the future. The staff web-portal have shown adequate interest up-to 62.5% among the users with suggestions and comments to add more features such as generating business charts and developing similar applications for internal business operations such as finance and human resources in the future.

General Terms
Management Information System, Sustainability, Rapid Application Development.

Keywords
Sustainability, Management Information System, Rapid Application Development, Web-based Car Park Booking System, Staff Web-portal, Airport.

1. INTRODUCTION
Muscat International Airport in Sultanate of Oman has become one of the major hubs for many national and international destinations, travelers and organizations alike. With the increase number of passengers, the new Muscat International Airport's car parking spaces will expand to include a capacity of 8000 car parking spaces in-comparison with the current 1542 car parking spaces. The aim of this research is to design, develop, implement and test: a website specially dedicated to Muscat International Airport which is also mobile compatible, a web-based airport car park booking system and a web-based MIS for the staff of the airport. The objectives are to provide the public and the customers of the airport with information about the new airport and its services and facilities, allow the customers of the airport to book a car parking space online, allow the customers to book a car parking space specially designed for customers in hurry because of their due flights & need to allocate the nearest parking slot for quick access to the airport terminal building, allow the customers to manage their reservation details, allow the staff of the airport to manage the airport services & facilities such as stocks, flights, vehicles, car parking spaces and financial information by generating reports and research the methods for greening the airport's IT resources to make the new airport sustainable.

2. CAR PARK MANAGEMENT SYSTEMS & TECHNOLOGIES
With the increasing number of transportation means such as cars, there is a much need to overcome the problems of traffic and finding a parking space. The following considerations are discussed in [7]: Smart Parking System is the car parking management technology that car park operators, car drivers and the environment can benefit from. Smart Parking includes five main categories, namely: Parking Guidance and Information System (PGIS), Transit-based Information System, Smart Payment System, e-Parking, and Automated Parking. E-Parking Systems allow reserving a parking slot using SMS or internet. E-Parking Systems can be further extended as it incorporates contact and contactless methods of the Smart Parking Systems for payments using mobile phones, credit cards or smart cards. A contactless method also utilizes Automated Vehicle Identification (AVI) tags using RFID technologies and also incorporates solar power and wireless connectivity. E-Parking Systems can provide customized information to the drivers either before or during the trip to the car park area to ease the location of the car park slot and allows them to reserve car park slots with different options as required. As E-Parking Systems are implemented online, they are also considered as *e*-commerce applications and it is proposed that Unified Modeling Language (UML) can be used to model the performance of the system. As explained by Hongwei & Wenbo [6], Ranjini & Manivannan [10] and Eswaran, Manikandan & Godha [5] the Parking Guidance approaches can be classified into four groups: Traditional Blind Search (TBS), Parking Information Assistant (PIA), Reservation-based Parking System (RPS) and Centrally-assisted Parking Systems (CPS). In RPS, the drivers can reserve a parking space through a website or through phone calls or by using SMS, however as a drawback, the parking space cannot be used by other drivers even if the parking space is not utilized.

3. AUTOMATIC TICKET MACHINES FOR CAR PARKS

According to Benelli & Pozzebon [2] the traditional steps of entering a parking facility by using automatic ticket machine attract security and operations issues. They address the issues of the ticket being lost or damaged once collected at the entrance of the car parking area. Another issue they address is the time consumed when customers wait in queues to make the payments at the kiosk and then receive the ticket again in order to exit the car park. Caulfield & O'Mahony [3] studied the passenger's requirements of public transport and their study shows that the Railway Procurement Agency in Dublin, Ireland procured contactless smart card technology to make the ticket payments easy. Their studies also show that the Transport authority in London, UK introduced the Oyster card since 2002 and was available as a pre-paid card since 2004. Benelli & Pozzebon [2] address the same issues with the smart cards as they can also be lost and their transactions are usually slow. They also studied the innovative services for tourists in Italy and explain that Near Field Communication (NFC) which is based on Radio Frequency Identification (RFID) technology can be used to enter and exit the car parks; as it utilizes mobile phones which integrate NFC technology to purchase tickets. They also explain that the factor that driven the NFC technology is the mobile ticketing and purchasing as statistics shows that in Italy there are 122 mobile phones for every 100 people [2]. SMS and e-commerce are among the solutions for mobile payments, but they do not involve any virtual money stored in a mobile phone. They further explain that NFC ensures first level of security by its short communication range which is lower than 10 cm between the mobile phone (the transponder) and the reader. Moreover, security key for the internal NFC memory in the mobile phones ensures a second level of security. They also explain that an additional security level could be added using encryption algorithms to further enhance the security of NFC.

4. MANAGEMENT INFORMATION SYSTEM

Management Information System (MIS) is one of the systems that are used to support strategic decision making in an organization. It is one of the systems that makes use of other systems input such as Transactional Processing Systems (TPS) and translate them into outputs as daily, weekly, monthly and yearly reports for the use of management position personnel. Ankur, Rachhpal & Robin [1] explain that database is the core element of MIS where it provides structural reports on regular basis for the management to support their decision making to achieve business goals. They further explain that the use of financial, accounting, sales and other information within the organization are the aim of the MIS to better study the business behaviour of an organization and make the right strategic decision to achieve the business goals.

5. E-PAYMENT

Online payment is a form of internet-based electronic payment using digital financial methods which includes consumers, banks, certificate authorities and payment gateways to "realize the processes" such as "online currency payments, cash flow, fund settlement and query statistics from buyers to financial institutions to sellers" [13]. As explained by Yongqiang, Yanrong & Aixiang [13] one of the most commonly used methods for online payments include bank cards (credit or debit cards). These transactions using the bank cards are processed with online payment protocols such as Secure Electronic Transaction (SET) and Secure Socket Layer (SSL).

6. AUTOMATIC NUMBER PLATE RECOGNITION

ANPR is also known as Automatic License Plate Recognition (ALPR), Automatic Vehicle Identification, Car Plate Recognition and Optical Character Recognition (OCR) for cars which uses colour, black & white or infrared to capture the images or sequence of images of number plates [11]. As explained by Chirag, Dipti & Atul [4] and Shan, Ibrahim, Shehata & Badawy [11] ANPR is one of the very useful approaches for vehicle surveillance and it is applied in tolls, car parking systems and as safety enforcement for traffic surveillance. Liam [8] explains that ANPR is expanding its functional applications on car park management including hands free access to parking facilities, vehicle theft, lost tickets and lost vehicles. As explained by Chirag, Dipti & Atul [4] and Shan, Ibrahim, Shehata & Badawy [11] ANPR identifies plate numbers using four algorithms/methods which include capturing the image of the license plate number, extraction of license plate number, segmentation of the license plate number and recognizing the characters of the license plate number.

7. GREEN COMPUTING

As explained by Murugesan [9] that IT is one of the major growing and cause of environmental problems and we are obliged to minimize its impacts to create a sustainable environment. He further explains that a holistic green approach is needed to comprehensively and effectively address the environmental impacts of IT which includes Green Use, Green Design, Green Disposal and Green Manufacturing of IT. He further explains that enterprises can take Tactical Incremental Approach or Strategic Approach or Deep Green Approach or a combination of all to pursue greening IT and ICT. However, Williams & Curtis [12] explain that IT ecosystem is complex and there is no "silver bullet or a single vendor solution that will magically make anyone green", however, because of the complexity of IT ecosystems which ranges from data centers, client computing, customer impacts to business impacts, some of its processes and decisions often involve trade-offs. They further explain that with all these complexities, "it is not entirely obvious yet what green outcome would even look like". They review one view of the multidimensional architectural complexities which calls out the interaction between technology areas, impact areas and green metrics areas. These areas form the sustainable architecture planning, but as explained by Williams & Curtis [12] these areas do not encompass everything; they provide a roadmap towards sustainable environment.

8. DEVELOPMENT METHODOLOGY

The proposed system architecture mainly focuses on three holistic approaches namely: Business, Systems and Users, as shown in Figure 1. This shows that the airport's business is interrelated with systems and users which as a whole also represent the Information System Strategy Triangle (ISST) which holistically includes Information, Organizational and Business strategies that when aligned together will successfully reach to sustainability.

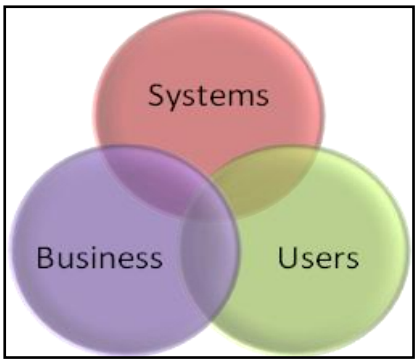

Fig 1: Holistic system architecture indicates that the relationship between the business, systems and users areas are interrelated

To further expand the above mentioned system architecture the detailed proposed system architecture as shown in Figure 2 below consists of data sources, data, business, service, presentation and cross-cutting components. These layers and components allow the systems to be better developed by integrating each layer with another and external systems and services. The website and the systems are further designed as UML and then developed and implemented using PHP Rapid Application Development (RAD) tools with customized PHP, MySQL and HTML 5 coding. The assumptions to develop the systems include the availability of e-payment gateways, ANPR, flight validation and security official systems integrated with each other. The website and the systems are then taken into the evaluation phase.

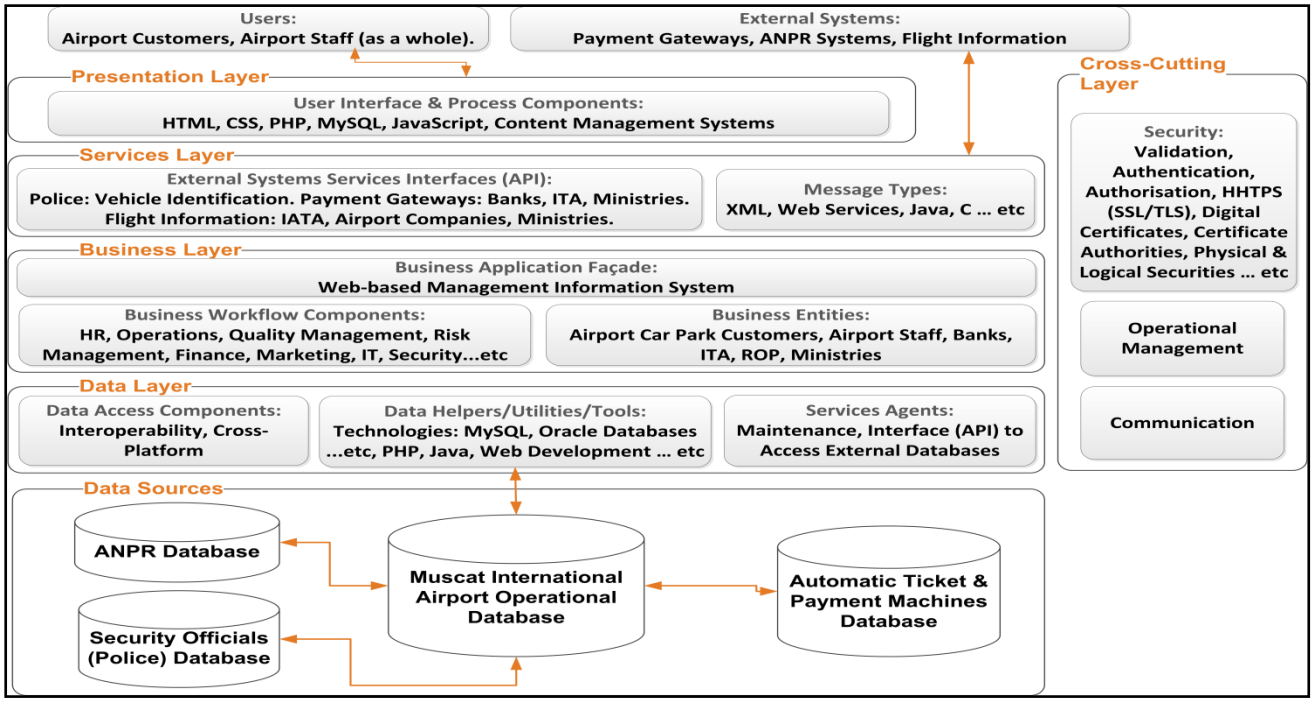

Fig 2: The Proposed System Architecture

9. RESULTS AND DISCUSSIONS

Based on the above mentioned assumption and subsequent to the evaluation analysis, results have shown that due to the unavailability of other external systems such as live flight, *e*-payments gateway and security officials (police) systems integrated with the current developed and implemented car park booking system, the system at the current development stage is not capable of validating the flight of the customers to check if they are genuinely late and need the nearest car parking space. Due to the unavailability of the ANPR and the security officials systems, the customer's license plate number cannot be validated at the current stage of the developed systems to check if the vehicle entering the parking area is stolen or not. Thus, to address these challenging factors, assumptions have been taken into account to incorporate the architecture with the implemented systems. The staff web-portal MIS has shown adequate interest from the usage perspective. It has shown significant amount of suggestions and comments to incorporate the future developments and enhancements of the systems. The implemented staff web-portal MIS supports generation of grid views where records could be created, added, deleted or updated. It also supports navigation through other internal business process reports such as finance, stock, customer's vehicles, customer's flight; customer's parking reservations, staff list, and parking stock. Customized SQL statements have been used to generate customized reports for the customers reservations with and without due flights. These reports can be generated and exported to PDF, Excel and other formats. It is found that the website, the web-based car park booking & its management systems and the staff web-portal has received wide acceptance with great interest. Practically found, 62.5% up to 70% of the systems designs, functionalities, features and services have been found useful and successful. As a result, the effectiveness of these combinations has been achieved and the functionalities have been identified as being very successful. However, to complement the weak and the missing components of the developed artefacts, the user's suggestions and comments along with the weak and missing components has been taken into the considerations of future work. Figure 3 and Figure 4 below show the results of the developed website and systems. The website has also been tested on

Android 4.3, Apple IOS 7 and BlackBerry OS 7 mobile platforms.

Fig 3: A taste of the developed and implemented front-end website for the new Muscat International Airport which includes the car park booking & its management systems within the car parking main menu. The website and the functionalities are also mobile compatible as tested on Blackberry, Apple and Android smart phones and tablets

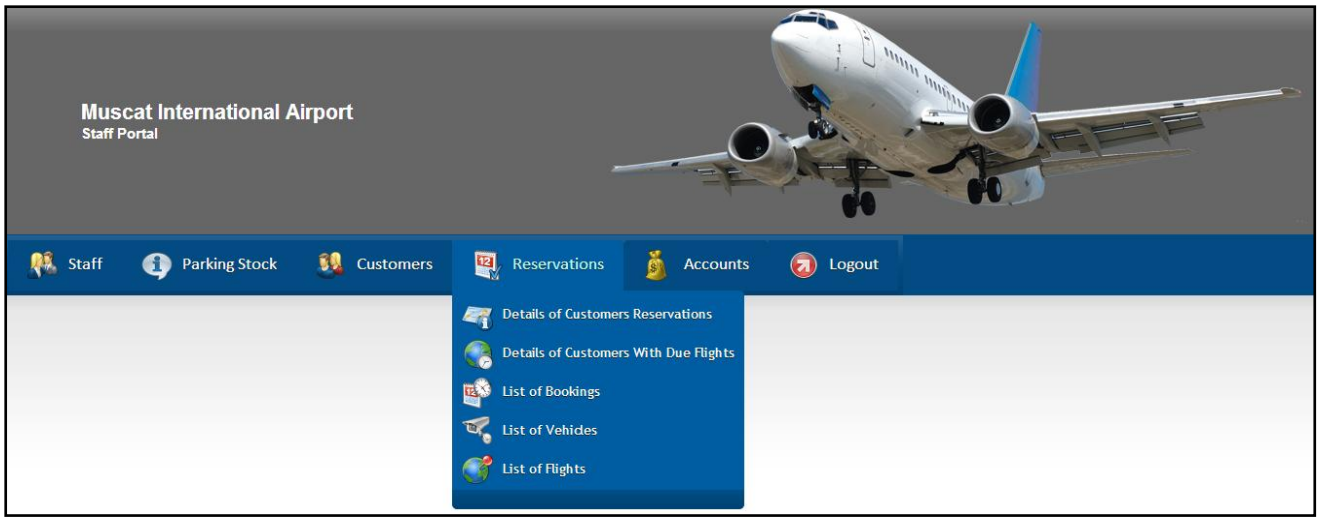

Fig 4: A taste of the developed and implemented front-end staff web-portal which includes options to a set of reports ranging from the internal staff reports to the customer's information and their related reservations

10. CONCLUSION AND OUTLOOK

The website, the web-based car park booking and staff web-portal management information systems are developed and implemented. However, outlooks to the aforementioned systems will incorporate enhancements to the implemented systems from different angles for the website, the web-based car park booking and the staff web-portal MIS. The proposed design blueprints could be revised to include more security considerations including encryption functionalities from the database and the scripting language perspectives. Other security considerations that could be used include digital certificates to secure the online bookings and payments. The car park booking system could incorporate more complex business logic rules to create a competitive advantage which could also be utilized as a mobile application. The external systems could be integrated with the current developed systems to overcome the challenges faced at the current stages. As the development improves, green technologies and metrics could be incorporated which will lead the airport towards sustainable business and environment.

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