

**DESIGN AND DEVELOPMENT OF A “PROPERTY MANAGEMENT
SYSTEM” SOFTWARE SUITE FOR HOTELS**

by

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Abstract

Following the rise of computers and the internet in the past two decades, the shift towards mobile devices in the late 2000s and more recently the growth of cloud services and cloud computing, the landscape of the hospitality business has shifted dramatically.

The bulk of room sales has moved away from telephone or walk-in customers, and traditional travel agents, to online travel agents, global distribution systems and the hotel's own website.

A modern hotel unit must adapt to these new standards, or risk falling behind its competitors. A hotel nowadays needs to be connected to several online sales channels, while at the same time, maintaining a strong online presence of its own.

The use of a modern PMS (Property Management System) can assist towards that end, by providing the necessary work structure, much needed automation and connectivity.

In this thesis, we explore these advancements in the hospitality business in detail, while, at the same time, having a comprehensive look into what a PMS provides and what benefits its use brings to a hotel.

The main focus of this thesis however, is the design and development of a brand new cloud-based PMS, using the latest available technologies and laying out its creative and development processes in detail.

Περίληψη

Η άνθηση των υπολογιστών και του διαδικτύου τις τελευταίες δύο δεκαετίες, η άνθηση των κινητών συσκευών κατά το τέλος της δεκαετίας του 2000, και πιο πρόσφατα η εξέλιξη του «cloud» και των υπηρεσιών του, έχουν αλλάξει δραματικά την βιομηχανία του τουρισμού.

Οι περισσότερες κρατήσεις δεν γίνονται πλέον μέσω τηλεφώνου, απευθείας στη ρεσεψιόν ή μέσω παραδοσιακών ταξιδιωτικών πρακτορείων, αλλά μέσω διαδικτυακών ταξιδιωτικών γραφείων ή απευθείας μέσω της ιστοσελίδας του ξενοδοχείου.

Ένα μοντέρνο ξενοδοχείο θα πρέπει να εναρμονίζεται με αυτά τα νέα δεδομένα, διαφορετικά ρισκάρει να μείνει πίσω από τον ανταγωνισμό. Τη σημερινή εποχή, ένα ξενοδοχείο πρέπει να είναι συνδεδεμένο με διάφορα διαδικτυακά κανάλια πωλήσεων, αλλά και να διατηρεί κι από μόνο μια ισχυρή παρουσία στο διαδίκτυο.

Η χρήση ενός μοντέρνου PMS (Property Management System) μπορεί να βοηθήσει σ' αυτό το σκοπό, προσφέροντας την απαραίτητη δομή εργασίας, απαραίτητους αυτοματισμούς και συνδεσιμότητα.

Σ' αυτή την διπλωματική, ερευνούμε σε βάθος τις εξελίξεις στην βιομηχανία του τουρισμού, καθώς επίσης και όσα προσφέρει ένα PMS και τα προτερήματα της χρήσης του για ένα ξενοδοχείο.

Κύριος όμως σκοπός της συγκεκριμένης διπλωματικής είναι ο σχεδιασμός και η δημιουργία ενός PMS που θα βασίζεται στην τεχνολογία του «cloud», χρησιμοποιώντας την πιο πρόσφατη διαθέσιμη τεχνολογία και παρουσιάζοντας σε βάθος τον τρόπο σκέψης και την μέθοδο ανάπτυξης.

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Finally, I must express my profound gratitude to my parents and to my wife for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis.

Author

Panagiotis Moraitis

Dedication

To my parents and my loving wife.

Definitions

PMS

PMS stands for Property Management System. It is software designed to help manage the daily operations of a hotel, such as reservations, guest database, check-ins/-outs, inventory management, display statistics and generate reports.

Hotel property management systems may have integrated or interface with third-party solutions like central reservation systems, revenue or yield management systems, online booking engine, back office, point of sale, door-locking, housekeeping optimization, pay-tv, energy management, payment card authorization and channel management systems [1].

Cloud Computing

Cloud computing is the use of various services, such as software development platforms, servers, storage and software, over the internet, often referred to as the “cloud”.

In general, there are three cloud computing characteristics that are common among all cloud-computing vendors:

1. The back-end of the application (especially hardware) is completely managed by a cloud vendor.
2. Users only pay for services used (memory, processing time, bandwidth, etc.).
3. Services are scalable.

Many cloud computing advancements are closely related to virtualization. The ability to pay on demand and scale quickly is largely a result of cloud computing vendors being able to pool resources that may be divided among multiple clients.

It is common to categorize cloud computing services as Infrastructure as a Service (IaaS), Platform as a Service (PaaS) or Software as a Service (SaaS). [2]

History, Current State and Evolution of PMS

Initial Reservations Systems

Originally, the information the hoteliers were collecting was very limited. Most of the time, they weren't dealing with reservations. The vast majority of their clientele was walk-in guests. As a result, the hoteliers only required a name, residence, room and time of arrival.

The proprietor is not responsible for the loss of MONEY, JEWELS, or other Valuables, unless deposited in the safe provided for that purpose.

DATE October 1954

	NAME	RESIDENCE	Room	Time of Arrival	Time of Departure
SEPT 30	Robert Osterman	Vancouver Wash	30	4:00 AM	
	Ed Thompson	Vancouver Wash	37	5:10 AM	
	Walter B. Jones	S.W. City	50	10:00 AM	
	Walter B. Jones	Vancouver Wash	9	9:00 AM	
	F.S. Wanser	Bathlamet Wash	36	8:15 AM	
	Geo Davis	Raner	14	8:35 AM	
OCT 1	Mr. & Mrs. D. Valentin	Yoklma Wash	18	12:30 AM	
	Jim Hunter	Vancouver Wash	34	2:40 AM	
	Sonnie Harrison	Little Rock Ark	30	3:10 AM	
	Mr. & Mrs. C. Houghlin	Enterprise Ok	6	4:00 AM	
	Alma Callahan	Fisco Wash	18	4:45 AM	
OCT 7	Dwight Fryman		14	12:30 AM	
	Robert Osterman	Vancouver Wash	32	12:30 AM	
	Geo. H. Ford	Lakeview Ore	34	13:45 AM	
	J.M. Roberts	Walters Ok	33	1:10 AM	
	Mr. & Mrs. J. J. Warren	Stanford Ok	17	1:45 AM	
	Mr. & Mrs. J. J. Warren	Stanford Ok	17	3:30 AM	
	P.H. Peterson	North Portland	14	6:55 AM	
	Geo. Ingram	Pineville	27	7:30 AM	
	Geo. Davis	Raner	6	8:35 AM	
	Geo. Clary	City	32	10:00 AM	
	Mr. & Mrs. R.		30	10:45 AM	

Figure 1: Hotel's guest ledger, 1954 [3]

When hotel reservations started to become popular, hoteliers needed a method to log reservations. This need brought about hand-drawn and printed reservations calendars, which allowed hoteliers to deal more easily with reservations and also tackle the problem of cancellations.

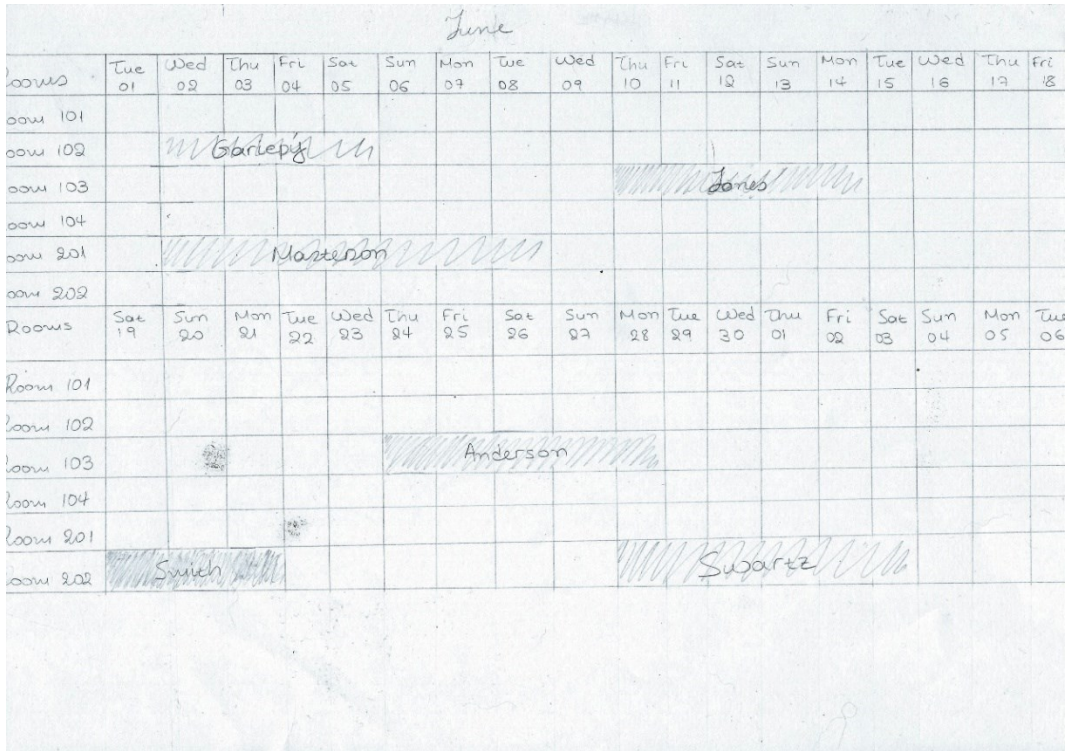


Figure 2: Hand-drawn monthly reservations calendar (1971)

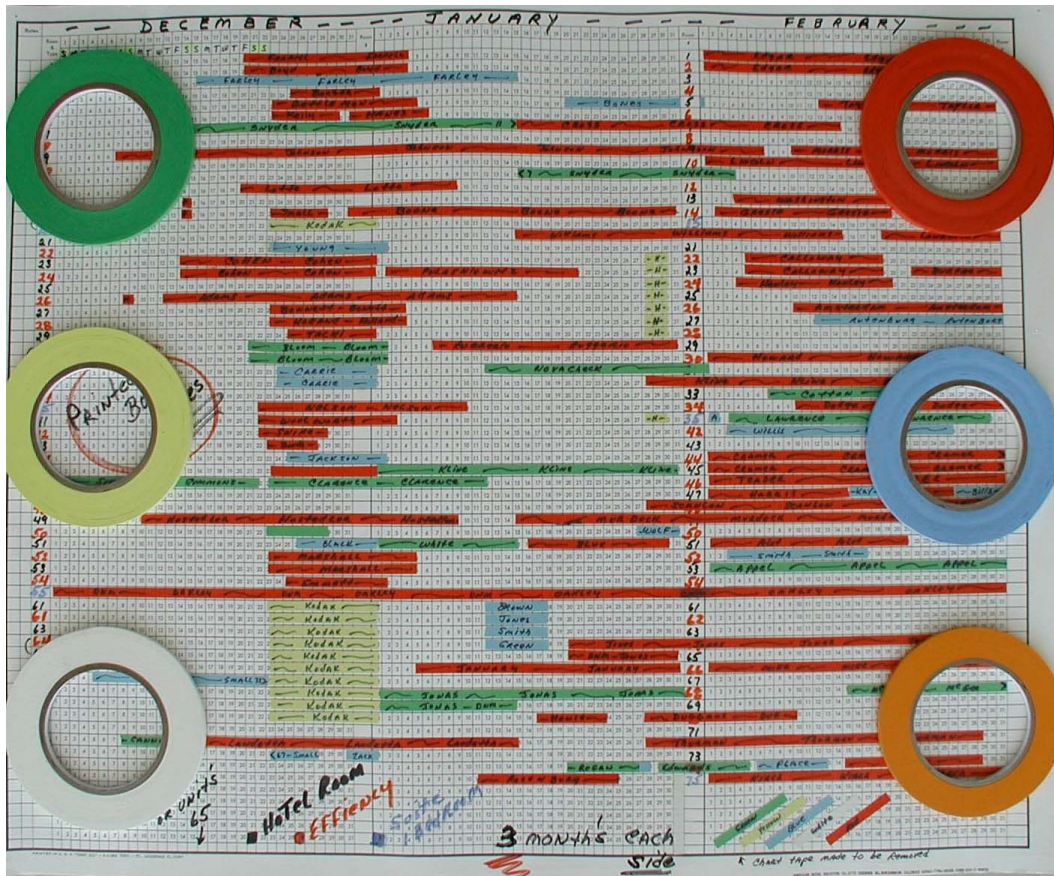


Figure 3: Physical tape chart [4]

Computer-based solutions

History Brief

In 1958, Sheraton hotel introduced Reservatron, the industry's earliest automated electronic reservation system, which made Sheraton the first hotel chain to centralize and computerize reservations [5].

In 1967, Sheraton updated that system with Reservatron II, a computer system for personalized reservations [5].

In 1970, Sheraton was the first to institute a toll-free 800-number system, allowing customers direct access to reservations [5].

In 1994, Travelweb.com emerged as the first comprehensive catalogue of hotel properties around the world and, a short time later, included a component to make bookings [6].

In 1995, Choice Hotels International and Promus were first to offer guests real-time access to central reservations [7]. Choice and Holiday Inn were the first to introduce online booking capability [7].

Excel Solutions

In the late 1980's, excel was released by Microsoft. It soon became a very popular utility for hotels to organize their reservations chart, finances and produce data reports.

In fact, a large number of mostly smaller hotels nowadays, still manage their business on excel-based solutions, like the one shown in the following figure.

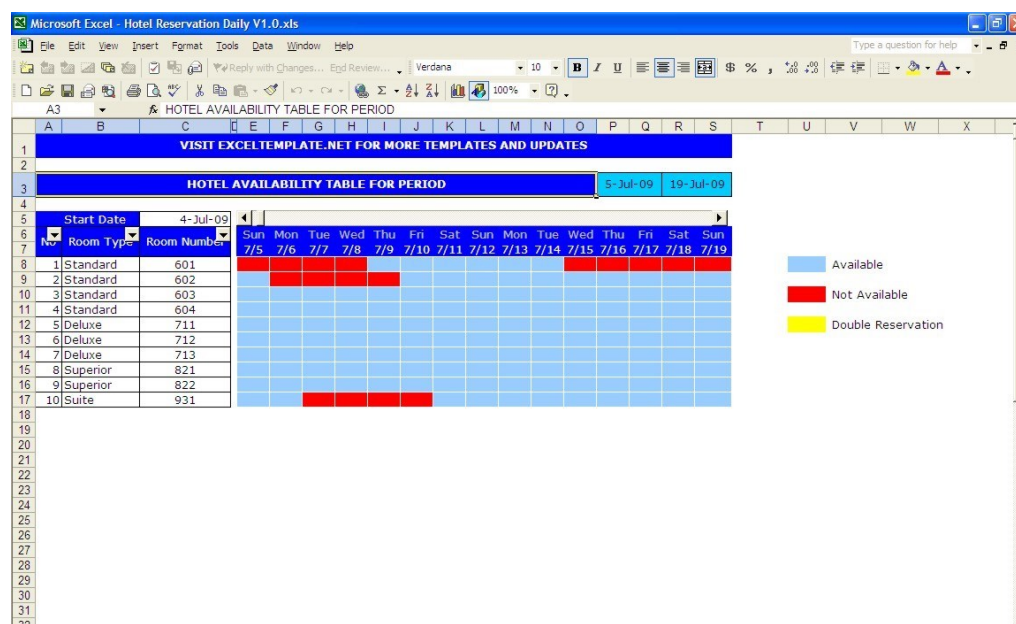


Figure 4: Reservations calendar in Microsoft Excel [8]

Initial PMS Solutions

Eventually, software for front-end tasks, like reservations, guest check-ins, and software for back-end tasks, like staff and pay management, was created. This led to the need to integrate separate solutions. This process could be complicated, expensive, and time consuming.

Recognizing the need for a simpler organizational system, the market for PMS was created. Solutions were designed to help track information, providing accessible data for optimizing operations on both the front- and back-end.

Most offerings are designed to integrate with a variety of additional modules, such as casino or spa management software. In this way, HPMSs can be configured to suit a variety of hotel chains. Moreover, there is now a move towards more advanced module integration, such as with energy and yield management systems. [9]

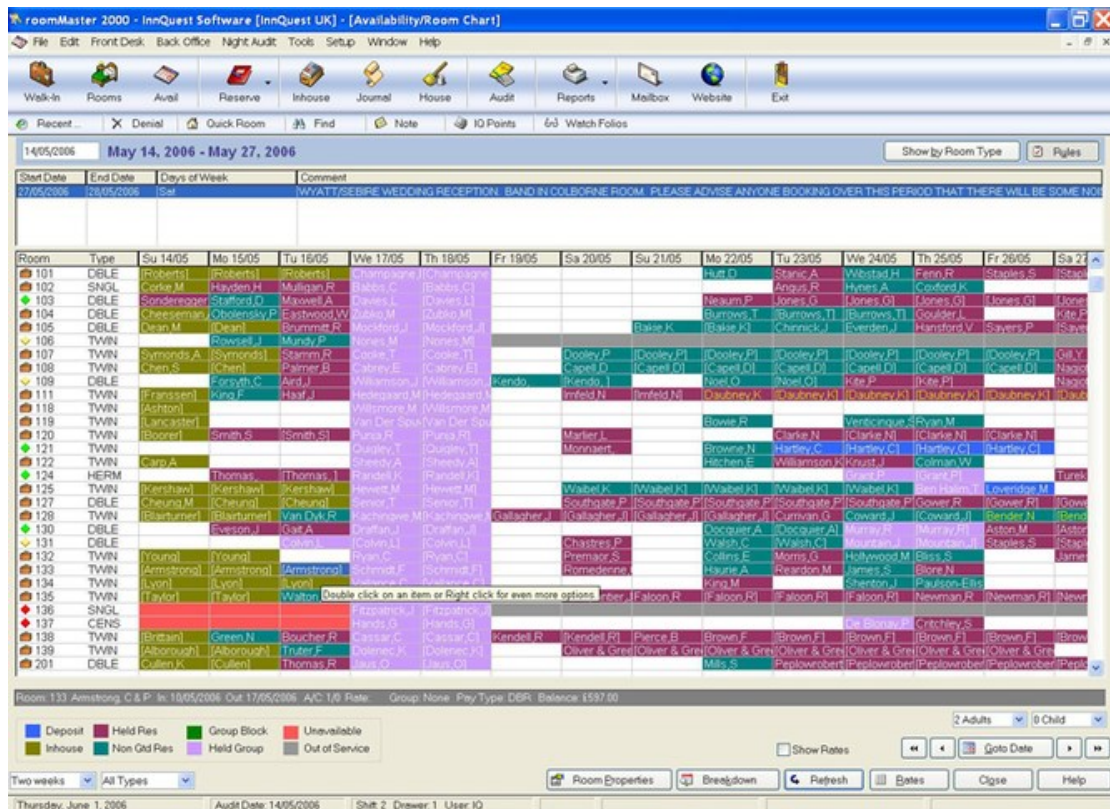


Figure 5: roomMaster 2000 [10]



Figure 6: eZee frontdesk - older version [11]

Modern PMS Solutions

In the previous decade, the introduction of computers and mobile devices into the mainstream audience has shifted the landscape of the hospitality industry. In particular, the distribution and booking end have changed dramatically, due to the surge of online travel agencies and consumer bookings moving away from traditional methods and into online systems and mobile devices.

Hotels themselves were slower to adapt, opting instead to stick with more traditional and well-established systems. However, this is now starting to change.

The facts are undeniable: about 148 million travel bookings are made online each year. That's 57% of all travel reservations made in a year. Even more importantly, 65% of last-minute reservations are made on a smartphone. [12]

Current trends show that hoteliers are finally embracing the use of cloud technology. Cloud-based solutions are steadily becoming more and more popular, due to established companies in the industry migrating their software to the cloud or offering and a myriad of new start-ups offering cloud-native solutions.

Many traditional PMS vendors have already launched cloud versions of their software, offering them in addition to the on premise solutions and many new PMS cloud solutions are being realized.

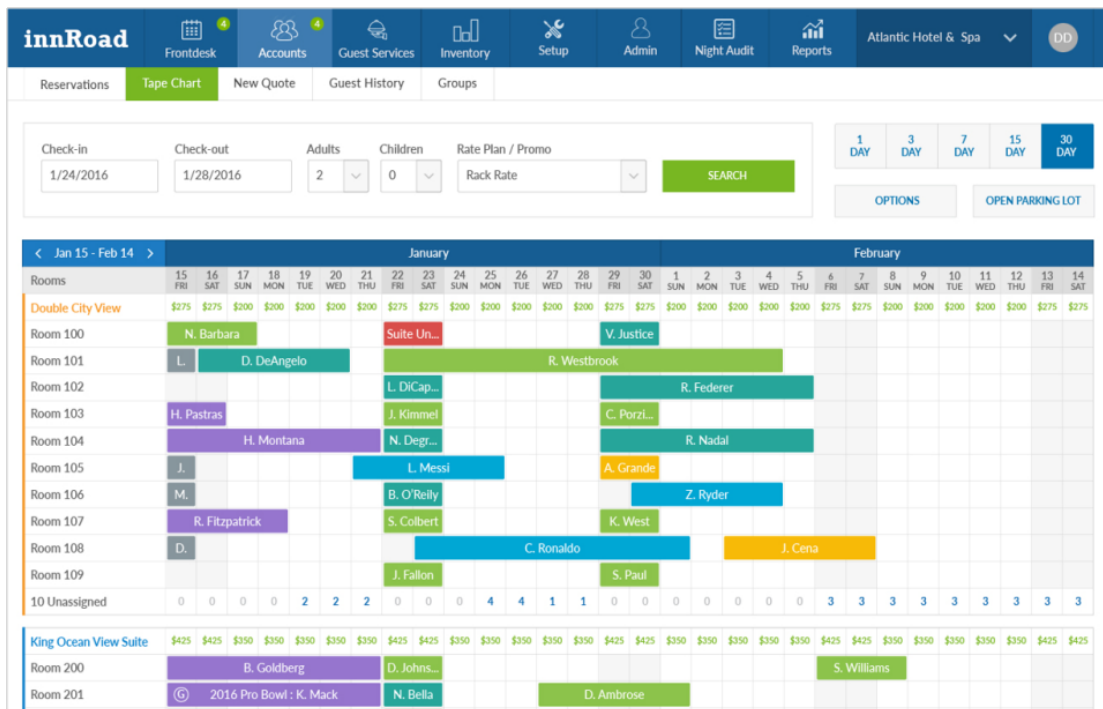


Figure 7: innRoad, a modern PMS solution [14]

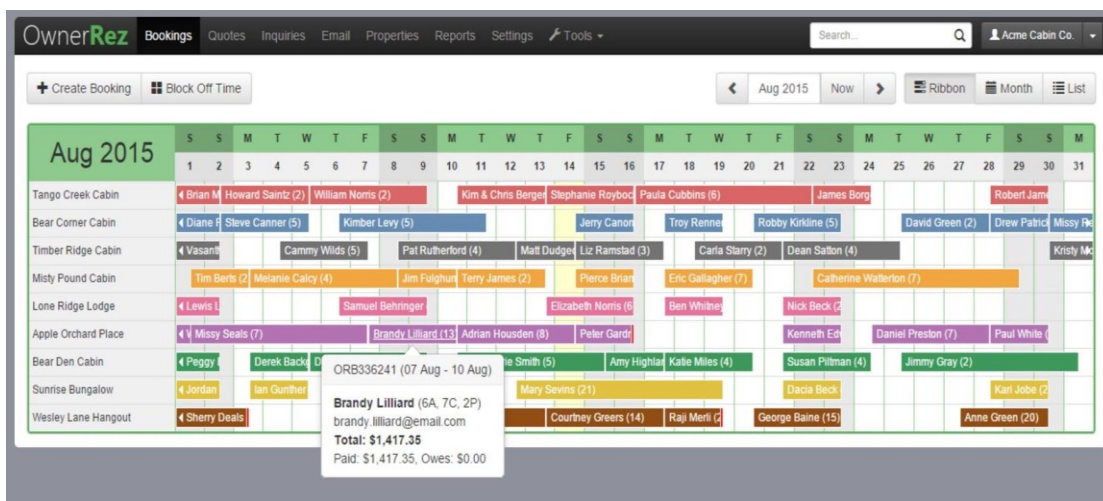
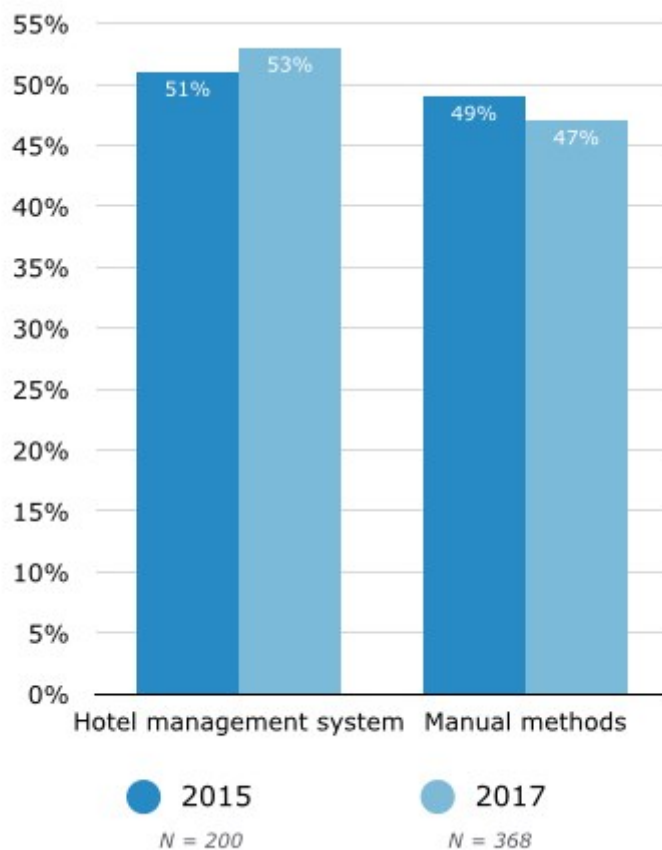


Figure 8: OwnerRez, a modern PMS solution [15]

Current Trends

U.S. Hospitality Industry Growth and PMS Solutions

As the hospitality industry continues to grow, we see that the adoption of a hotel-specific management system has increased by 2% from two years ago [16]. At the same time, there's a 2% decrease of manual methods, which include pen and paper or spreadsheets [16].



Graph 1: Hotel Management Methods [16]

This suggests that more hospitality companies recognize the benefits of a hotel- specific PMS [16].

The Need for Evolving Modern Property Management Systems

Nowadays, hoteliers' expectations of a property management system have grown. In addition to front- and back-end tasks, current solutions are expected to integrate third-party solutions. Moreover, they need to enable hotels to leverage guest information in order to create effective targeting campaigns [17].

The number of PMS providers is ever growing and “commissions are increasing at twice the growth rate of industry-wide revenue” [17]. This also raises the demands hoteliers have of their PMS. Front desk organization and tasks may still be the most requested feature, but now, hoteliers also want to be offered tools to improve their business and bring in more guests.

While being able to interface with third party solutions, like yield / revenue management systems, channel managers and rate intelligence tools can

help, the PMS needs to offer at least some level of built in functionality in these key areas. A simple evaluation process can also assist properties in decision making.

Automated tools are also in high demand. For instance, a basic level of pricing automation can be of immense use to smaller hotels that want better pricing management without having to invest in an all-out revenue management system. Having the capacity to automate room rates based on the occupancy level in the property, enables hotels to generate more revenue when occupancy is high. Moreover, by lowering prices during periods of low occupancy, properties can create demand during the off-season. [17]

As more and more travelers consistently research and make bookings online, the hotelier's goal should be to maintain a strong online presence, in order to make their property visible to the traveler as soon as possible, during their selection process and make their listing attractive enough to secure a booking. [12]

PMS and the rise of new technologies

Integrating PMS with Other Software and Innovations

Integration is crucial for modern property management systems, as it provides an easy way for hoteliers to use all of the data collected by their PMS, "enabling them to adequately deal with pricing, promoting, segmenting according to demand" [18].

Integrating real-time communication tools and AI technology allow hoteliers to offer guests unprecedented customer support. Additionally, by integrating other solutions, hoteliers can "have access to reports, analytics, and guest reviews and ratings, which will enable them to enhance their service and drive in more guests" [18].

The most commonly integrated solutions are: "POS, CRM (Customer Relationship Management) framework, CRS (Central Reservation System), Payment gateway, Revenue Management System, Sales and Catering System, Wi-Fi, Mobile Check-in and Check-out program, door lock, accounting system etc." [18].

The shift to mobile

The shift from desktop computers to mobile devices, like smartphones and tablets, which began in the late 2000s, continues today. In fact, the rate at which this transition is taking place, is increasing and expected to continue to do so, in the coming years.

While traditional desktop environments and portable computers will always play a significant role for a PMS, it is becoming increasingly vital that a PMS is mobile device capable, offering the same features and ease of use, as it does in a desktop environment.

This is usually achieved in two ways: either through a separate mobile app for each platform (android, iOS etc.) or by using responsive design (for cloud-based solutions) to make the application adapt to the device it is being displayed on.

A mobile friendly PMS must provide a potential guest the ability to book a room in hotel in a user-friendly way, through its booking engine, as well as offer services and upgrades for in-house guests.

From a hotel's perspective, it should provide the same range of features and ease of use that a desktop version would provide, as well as potential additional features, such as electronic check-in, housekeeping status updates and more. The property staff should no longer be bound to the reception in order to interact with the PMS.

Artificial Intelligence

Artificial intelligence (AI) is the cutting edge on the hospitality business, and is actively redefining the industry, freeing hoteliers and personnel from having to deal with various aspects that require lot of time, effort and manpower. AI driven systems adapt and evolve, based on their interactions, to better perform their role.

The most widely recognized AI application in the hospitality industry are chat-bots. Chat-bots offer great benefits in regards to guest interaction and communication. They usually interact with guests through online chat or messaging services. Among other things, they are also used to assist potential guests in a making a direct booking and provide room service once inside the property. In general, they are able to respond to guests' inquiries and provide satisfactory solutions, 24 hours a day, reducing the time required to provide service to customers.

Overview of Different PMS Models

On-premise

- The traditional solution for PMS, typically installed on hotel computer and accessed via a desktop machine [13].
- Application hosted and data stored on a server located on the hotel premise [13].
- Software application designed for Microsoft Windows operating system [13].
- Capital investment in hardware (computers, terminals, servers...) and upfront license fee for software (perpetual license) [13]. Updates are usually paid for [13].
- Usually acquired with a contract for service and maintenance [13].
- Systems have typically been developed over a long time and have rich functionality [13].

Hybrid Clouds

- Legacy solutions which have transitioned from on-premise (having been written for Windows OS, eg. in Java) and given a web front-end for access via browser on computer, tablet and mobile [13].
- Can be hosted locally or remotely from PMS providers' server at data centre [13].
- May still have certain elements on desktop [13].
- Subscription based pricing model, typically calculated as a fee per room per month [13].
- Initial set-up fee (with additional charge for interfaces & training)/migration fee from on-premise [13].
- Quicker to develop than web-native as do not need to rewrite all of the code [13].
- Greater depth of functionality than web-native as has all the functionality of the legacy system [13].

Web-native Cloud

- Designed purely as a web-based solution – optimized for tablet and mobile use [13].
- Accessed via internet browser [13].
- Can either be hosted via:
 - Private cloud – PMS providers' servers at data centre [13].
 - Public cloud (e.g. Microsoft Azure) [13].

- Often referred to as “pure cloud” and has more advantage of being more agile and open to multi-tenancy [13].
- Designed specifically as web software and so mobile functionality is higher, typically easier to use and faster to launch updates [13].
- Subscriptions based pricing – per room per month with a potential initial set-up fee [13]. Updates typically included in the package [13].
- Easier to interface with other systems [13].
- Recently developed and so solutions can lack the richness of functionality required by hotels with complex operations [13].
- Needs internet connection to operate [13].

Analysis of PMS Subsystems

Property Management Systems

PMS represents the back-bone of hotel operations and interfaces with a variety of other key systems from channel management and bookings to hardware as telephony and key rooms. In the past, PMS was used to manage guest check-in and check-out and housekeeping services. However, now PMS covers the entire guest experience, including the booking process to capturing guest data for future interaction. [13]

Larger hotel groups with international operations may opt for an ERP (Enterprise Resource Planning) solution, whereby a technology supplier offers a comprehensive end-to-end solutions integrating front desk and back office functionality. Although the concept of an ERP in the hospitality industry is still relatively new, it offers numerous advantages in terms of seamless use of technology, more automation, greater visibility into hotel operations, optimized use of manpower, reduced revenue leakages and higher resultant profits. [13]

Benefits of using a PMS:

- The amount of daily hotel operations is reduced due to the automation of repetitive tasks.
- The necessary work structure is provided so that operations can be performed in a standardized manner making them easier and less prone to mistakes.
- The latest data and information is readily accessible, helping staff & management in making informed decisions.
- Increased security due to data being more difficult to compromise when records are maintained by the system.
- Guest experience can be personalized and improved with accurate recording keeping, preferences and detailed information available.

PMS Subsystems:

Below is a comprehensive list of features commonly found in PMS, broken down in 3 categories:

1. Front desk systems
 - Reservations
 - Customer database / History
 - Guest registration
 - Guest Accounting

- Guest messaging
 - Housekeeping (Room management)
 - Night Auditing
 - Sales & Catering
2. Back office systems:
- Material Management System (MMS)
 - Management Information System (MIS)
 - Financial Accounting System
 - F&B Control System
 - Human Resource Information System (HRIS):
 - Rate management
 - Online booking engine
 - Channel manager
 - Reports & statistics
3. Miscellaneous functions
- Hotel Security integration (Keycards)
 - Electronic Concierge
 - Point-of-sale (POS) System
 - Activity logging
 - Pricing automation tools

Analysis of PMS Subsystems

Reservations Module:

This module is used to record and display reservations made for the hotel. Reservations are usually displayed in a calendar-like interface, where each column represents a date and each row a different room.

When a reservation is made, the following steps are usually required to record it in the PMS (either manually or automatically):

1. The reservation is assigned a room based on the dates and room type requested. In modern PMS, reservations made through online travel agents or the hotel website are automatically assigned a room by the PMS, whereas reservations for walk-in customers, via telephone or 'offline' travel agents will need to be assigned a room manually by the front desk staff.
2. After a reservation is assigned a room, the guest's details need to be recorded into the reservation. Typical customer data includes: full name, company, gender, date of birth, nationality, contact details, preferences and more. This data may be provided and recorded automatically for reservations made online.
3. Next, more details about the reservation is recorded, such as the room occupancy, meals, the source of the reservation, the payment method, payment details and other data, like possible check-in, check-out times, special requests and comments.

4. Once all the information is recorded and the reservation is inserted in the PMS database, a confirmation message may be sent to the guest's email or the travel agent informing them that the reservation has entered the system. If the PMS is connected to online travel agents or a booking engine, the updated room availability may be pushed to these channels automatically, or may need to be adjusted manually.
5. The PMS reservations module will display a list of reservations in a graphical way, usually called a tape chart, reservations plan or reservations calendar, where the hotelier and the front desk personnel can view in a straightforward way which rooms are booked in specific dates. Through this interface, users of the PMS are also able to make modifications, move reservations around or make cancellations.
6. When a guest arrives at the property, the status of a reservation can be modified to indicate the guest has checked in to his room. The status can also indicate if the amount of the reservation has been paid fully or partially.
7. The reservations module may also be used to post extra charges to the reservation, during the duration of a guest's stay.
8. Upon check-out the front desk staff can use the reservations module to provide a receipt to the guest for his stay, including the room rate, meals, extra charges and so on. This system may also be used to generate invoices to travel agents, if applicable.

Customer Database/Guest History:

Detailed information for every guest previously booked in the property is automatically recorded and maintained, when new reservations enter the system. This information usually includes the guests' full name, date of birth, nationality, company name and contact information.

Remarks relating to likes and dislikes, room type booked, exact room used, preferred payment method, etc. can be included automatically or manually.

Guest history plays a big role in promoting the hotel and its amenities to returning customers, since hotel personnel have all the available information about the guest's preferences and are able to make the guests feel right at home by offering them their preferred room and amenities.

Guest Registration:

Guest registration refers to the collection and saving of information regarding a guest of the hotel. This can happen automatically through the reservations module; as new reservations are entered in the PMS. Another method is through electronic check in modules or simply with old-fashioned way of guest registration at the reception.

Guest Accounting & Check-Out:

Upon guest check-out, the PMS is able to provide accurate billing information, based on the amount due, displayed in the reservation.

The guest can receive a separate receipt/invoice for different services, such as the room stay and extra charges made on premise during his stay. The PMS can interface with a POS to provide online charges straight from within the application.

Guest communication:

A PMS should have built-in tools to communicate directly from the system with registered guests of the property. This is usually achieved through email or SMS messages and can be used to inform guests of special offers, promotions or planned events. This feature is also very handy due to the fact that guest communication history is visible straight from the PMS along with all the other information already stored.

Automated messages can also be configured, for example, to send booking confirmations to guests or tour operators, when a reservation has been inserted or has been successfully modified in the system.

Room maintenance/housekeeping:

This module allows the front desk personnel to keep track of the housekeeping and maintenance status of all rooms available in the property, along with their existing and upcoming occupancies. This makes it easy to plan the work schedule of housekeeping and maintenance staff. Once room maintenance is complete, the room status can be updated on the spot, by utilizing terminals specifically for that purpose or through mobile devices carried around by respective personnel. Having live updates on room status and help minimize waiting times and increase guest satisfaction.

Night Auditing:

One of the most important functions of daily operations of a hotel is the night audit. This process posts room tariff and taxes automatically on the guest's folio and helps confirm and reconcile the final balance of the entire day's transactions. During the night audit procedural rights of front office staff are limited and therefore the PMS needs to have features that can allow other non-accounting tasks to be carried out during the night audit process.

[19]

Rate Plan & Contract Management:

A crucial feature of a PMS solution is to provide the right tools to effectively manage the different rate plans and contracts of a hotel. These tools should allow for a user friendly way to import all the various aspects of a rate

plan/contract, such as price models per room-type and time period, meal supplement pricing, the management of various discount options that may apply (early booker discount, long stay discount, etc.), room extras pricing, booking cancellation policies and booking restrictions. The PMS should be able to supply the various aspects of a rate plan or contract automatically to its other modules and connected channels. When a reservation is made in the calendar module for example, the PMS should provide pricing automatically, based on the rate plan or contract selected. There should be no need for manual calculations, which could result in billing errors.

Channel Manager:

Nowadays, modern hotel businesses are connected to many different online travel agents and global distribution systems, which provide room sales. Managing the inventory and pricing for each one of them separately can be a full-time job in itself on a mid to large property. The PMS should be able to connect to these sales channels and provide inventory management based on the number of vacant rooms for each date, in real time, in order to distribute these rooms to all sales channels simultaneously, for maximum market exposure and to avoid overbookings. The PMS should also supply prices based on rate plans to sales channels, all without user intervention. Manual inventory and rate management should also be an option.

The PMS should also allow the easy creation of promotions and update all connected or selected channels.

Pricing automation:

Revenue management tools allow hotels to set the appropriate rates after running through several occupancy scenarios. According to the August 2010 Hospitality Revenue Management report, those organizations that have invested in an integrated revenue management tool have seen a gross margin increase of 3% compared to a 4% decrease for those organizations that have not. Proper pricing strategies based on occupancy, demand, customer trends, and competitive pricing tactics need to be implemented in the property management system. This visibility into pricing strategies for the revenue manager allows for more targeted pricing and promotion campaigns.

Booking Engine:

One of the leading sales channels in today's market and the one currently growing the most, is a hotel's own website. A modern PMS solution should provide an online booking module, which can be integrated onto a hotel's website and provide visitors a secure, user-friendly way to make their reservation, eliminating the need for a middle man and securing the best

possible price for the guest. Rates and availability should be provided by the PMS and reservations made through this system can automatically appear on the reservations module.

Reports:

Hoteliers and back-office staff need access to powerful statistics and reports to help them realize their sales potential and maximize the business' occupancy and revenue.

A modern PMS should be able to provide these statistics and reports using graphs & charts and generate data to use with popular external tools, such as excel.

Useful reports can include:

- Daily transactions
- Average guest stay length
- Occupancy chart
- Monthly revenue chart
- Occupancy/revenue stats per room type
- Sales/revenue per channel chart
- Meals and room extras statistics
- Guest nationality stats

And many more.

Activity logging:

Every action on a PMS that inserts, deletes or modifies the data in the property database should be recorded, for the purpose of tracking changes made in several modules of the application, as well as the exact timeline of these changes.

It is very handy, for example, to be able to track changes made on an individual reservation, such as date changes, extra changes posted, reservation status modification (check-in, check-out) etc., and by which user they were made, along with the exact timeline.

Sales & Catering:

This module focuses on the spaces offered by the hotel for conventions and other occasions, such as weddings. It acts as a calendar and usually includes information regarding the type of event, dates, the cost per pax, if a buffet is offered and employee assignment to that particular event. An important of this module is the billing or posting of transactions to the Sales Ledger which can then be handled efficiently by the F&B staff [19].

Material Management System – MMM – (Stores & Purchase):

This covers the entire material management operations, such as requirement planning, purchase, receiving of stock, costing, etc. The system also provides information for effective decision making and budgeting [19]:

- Purchase requirement is effectively managed helping in better management [19].
- It can store the history of purchase vendors in order to efficiently study cost analysis for lower purchase costs [19].
- It can be able to give automatic reminders on pending purchases, which is helpful during high occupancy [19]. This ensures for timely supplies [19].
- Easy monitoring of stock [19].
- Assists management in making effective purchase in relation to proper storage area [19].
- Provide for automatic stock accounting details [19].
- Facilitates on the spot checking of stock [19].
- Facilitates comparison of market trends for analysis and decision making [19].

Management Information System (MIS):

The MIS should provide statistical information to the management to assist in decision making and revenue control [19]:

- MIS provides the database regarding forecasts and budgets, which helps management in establishing room rates [19].
- Comparison of budgeted figures along with actual figures established by sales & marketing department in relation with front office helps the management to address the problem in case of losses [19].
- An MIS should provide data which is comprehensive, accurate and detailed with business and sales analysis to ensure increased revenue and higher occupancy [19].

Financial Accounting System:

This module provides information required for basic accounting as well as financial management of the hotel. Its main features are [19]:

- Integration of account receivable, account payable, material management, ledgers, and payroll in the financial accounting system [19].
- An accounting system facilitates the administration in audit reconciliation on a daily basis, comparing of cash with raised vouchers, etc. [19].
- Monthly information regarding balances, profit and loss statements is also prepared [19].
- Provides timely updated and accurate financial information to accounts receivable for future financial control [19].

- Forecasts daily cash flow for better cash management [19].
- Comparison of budgeted to actual revenue and related expenditure is efficiently managed [19].
- Timely financial statement of accounts is made available [19].

Food & Beverage Control System:

This an important area of concern as a major POS which can raise revenue and create a lot of savings through control of F&B by minimizing wastage of material [19].

- An efficient control system should establish standards of raw material usage in order to minimize wastage [19].
- This should highlight raw material consumption reports in case consumption is exceptionally high [19].
- It should automatically pick up sales details for the POS system [19].
- This should also control and check beverage consumption through the POS [19].

Human Resource Information System (HRIS):

The human resource of the hotel is an important and expensive asset. A good HRIS should integrate the requirement for effective career planning, personnel administration, and payroll information. [19]

- The system should include comprehensive data regarding personnel career development as well as future manpower requirements [19].
- Should facilitate extensive reporting on appraisals [19].
- Should facilitate a complete database on leave and attendance [19].
- Should facilitate comprehensive and detailed payroll system with automatic salary calculation and printing of pay slips [19].

Hotel Security Integration:

This includes electronic locks and computerized card systems [19].

- Other locking systems such as recording signatures, fingerprints (for biometric scanners and access), and attendance of employees are all a result of technology [19].
- This also facilitates guest room video check in and check out in some hotel properties [19].
- Telephone services, hotel security alarms, guest's wakeup call services are all managed by telephone operators, but are an important part of hotel security [19].
- Energy conservation features may be associated with the computerized key system to ensure that the light connections are being incorporated with the card key when placed in a slot [19].

Electronic Concierge:

Marketing techniques are widely utilized by hoteliers in order to attract perspective guests to their hotel. Most of the times, though, marketing stops at the check-in. E-concierge is an amazing tool that helps hoteliers market their products and services to their guests during their stay. Hoteliers can use this tool as an advertisement mechanism and selling point of the hotel's products and amenities, to publish event calendars and provide guests with the local news. It can also be used to book local diners, theaters, concerts etc. Lastly, it can be used to provide guests with a virtual tour of the hotel or even the resort.

Point-Of-Sale (POS) System Integration:

A POS system is made up of a number of terminals located at various outlets or points of sale in the hotel. Each POS terminal contains its own input and output components which are interfaced with a remote central processing unit. The interface allows the electronic data to be processed, and transferred to guest folios when required, thus reducing the time required to post a charge in the appropriate guest folio and recording of the F&B sale at the same time. [19]

- The essential information input at the POS is the identity of the server, location of the customer (table number), number of covers and menu items being ordered [19].
- This order is electronically transmitted to the kitchen where it is printed as a KOT. This reduces the number of trips of the server/waiter to the kitchen [19].
- An additional function could be that the order for hot items can be printed at one location and that for cold items at another location [19].
- The prices of all menu items, food and beverages, can be stored allowing for printing or settlement of the check [19].
- When the guest settles the check, the settlement method (cash, credit card, city ledger or room settlement) can be entered and specified from the terminal on the check [19].
- At the end of the shift, a server can obtain the report of all unsettled or open checks. Usually, all checks are required to be settled or closed by the F&B supervisor [19].
- Each check raised for a room settlement (for an in-house guest) should be signed by the respective guest [19].
- A credit card EDC (Electronic Data Capture machine) will have all the details of all credit card sales [19].
- Once all checks are settled, a check settlement report showing details of total sales and its breakdown will be printed. This report will be the basis of balancing of F&B sales during the night audit [19].

Cloud Computing for Hotels

It's an unfortunate truth that hotels are sometimes behind the curve when it comes to adopting the latest technology. This makes sense, as hoteliers are first and foremost focused on the human side of the business: taking care of guests. After all, it is called the hospitality industry. In the end, this delayed adoption of new tools can work in favor of hoteliers, as new tech is tested by other more adventurous users before being adopted by the wider hospitality industry. Yet, hoteliers who wait too long miss out on innovative new ways to increase guest satisfaction and revenue. [20]

Thankfully, it's safe to say today that one of those new technologies, cloud computing, is both revolutionary and reliable. Cloud computing is really quite a simple concept. Your computer, POS, or other operational system sends data over the internet to data centers in other locations. The digital heavy lifting is done elsewhere on far more powerful computers, rather than all on the computer at your desk. Cloud computing still has some drawbacks, however, that should be taken into account when choosing a PMS. [20]

Benefits of the Cloud

Let's have a look at a few of the advantages that the use of a cloud-based PMS can bring to a hotel:

- **Available on any device and any location:** The most obvious advantage is that the PMS is accessible from any computer, regardless of the operating system being used and from any relatively modern mobile device, such as smartphones and tablets, with an acceptable screen size. The hotelier can, for example, check for arrivals/departures, whether he is at his office, at home, in a meeting or any other location. This benefits the hotel staff too, as they are no longer tied to a specific terminal or the front desk and can offer their services on the go.
- **Integration:** Cloud-based PMS are usually easier to integrate with third-party solutions, such as central reservation systems, revenue or yield management systems, POS and channel managers, compared to on premise systems, through the use of APIs designed specifically for that purpose. Older systems were much more proprietary.
- **Scalability:** Cloud technology is scalable by design. As a hotel's or hotel-chain's size and operations grow, the cloud vendor is able to scale the processing power and data storage needs to match the demand. This obviously comes at an additionally service cost from the

vendor, but that is far less costly than having to upgrade a business' own infrastructure.

- **Always up to date:** Another benefit of cloud based software, is that software updates happen on the vendor's server and therefore, everyone is always using the latest version. This prevents compatibility issues between terminals using different versions of the software and saves time for I.T. personnel spent on upgrading different machines.
- **Redundancy:** Server failures and malfunctions have the potential to be disastrous, when dealing with traditional on premise solutions, especially on the enterprise level. They can lead to data loss, data corruption and extended downtimes. By choosing a reputable cloud vendor, the customer no longer has to worry about such issues.
- **Lightweight:** Cloud-based software has very little requirements in terms of processing power and storage. Any old computer that can access the internet, or a mobile device, can be used to operate a cloud-based PMS; which leads us to the next point:
- **Lower cost:** Cloud based software typically trades the upfront cost of on premise solutions for a subscription-based pricing model. It also eliminates the need for specialized hardware purchases (servers) and saves up on I.T. personnel cost.

Possible drawbacks of the Cloud

Even though cloud-based PMS offer great advantages and are now considered an established product, there are still some areas of concern.

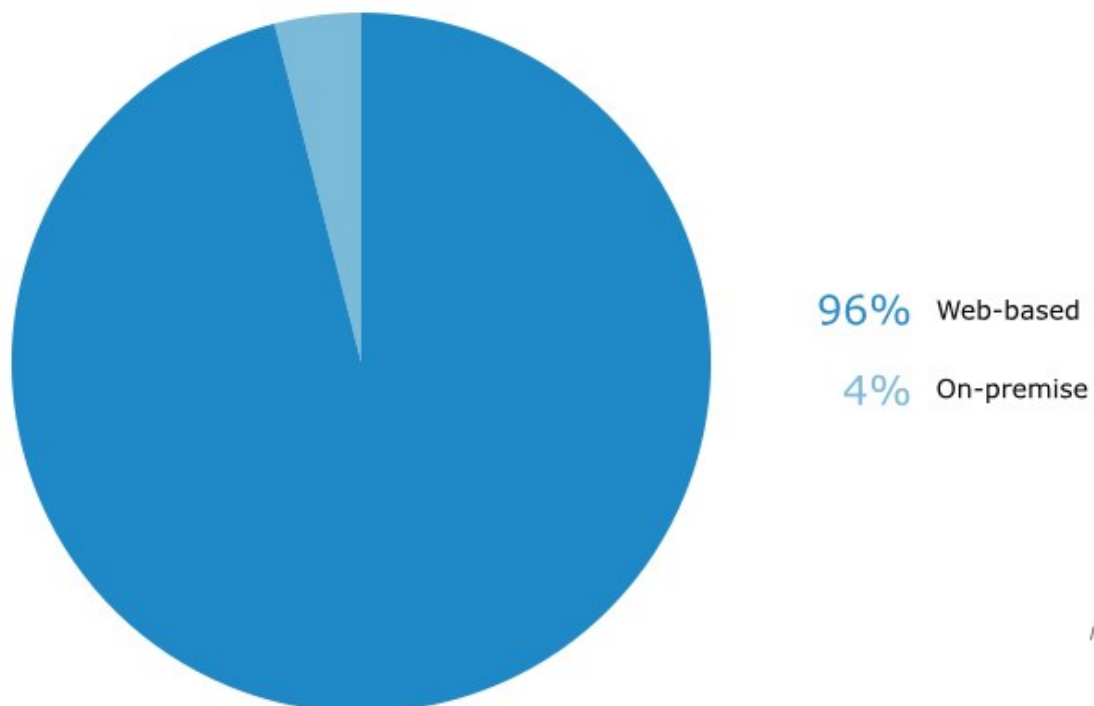
- **Service quality depends on the internet connection:** Quality of service depends on the quality of the internet connection of the hotel and the amount of bandwidth available. This can sometimes be an issue when there are other bandwidth-intensive operations happening or the internet connection itself is poor in that location.
- **The need for backup connectivity:** Since all data is stored on the cloud vendor's infrastructure, the loss of internet connectivity is a major issue. The hotel must invest in some kind of backup internet plan, usually in the form of a data card or mobile internet. Their use usually comes with additional costs but this cost is deemed insignificant compared to a lengthy service outage.
- **Central outages:** While rare, service outages do happen, even on reputable vendors and OTAs and there's nothing the end-user can do about it, other than having some kind of a backup system in place that can satisfy some basic operational needs. Thankfully, cloud services downtime is rare and usually only lasts for a few hours.
- **Security:** With cloud technology, all of the hotel's sensitive data, like guest profiles, billing information etc., is stored on the vendor's infrastructure. If this infrastructure is not adequately safeguarded, then sensitive information could leak.

To cloud or not to cloud?

So what does it all mean for hotels? Cloud computing isn't the go to solution for all hoteliers. There are some technical hurdles or at least some things to consider when deciding to use cloud-based technology for a hotel. If the hotel is in the developing world where internet connections can be less than reliable, the hotelier should think hard about this technology is for their hotel. [20]

But for most hoteliers, cloud-based technology is a major win. It provides far more powerful software that is also more flexible and adaptable. Like any product, it pays off to understand how it works, and have backups in place in case of the rare chance where something doesn't work as it's supposed to. In conclusion, cloud technology offers so many benefits, they vastly outweigh the drawbacks. [20]

This is the reason why we're approaching a time when more and more software is cloud-based. It seems that 96% of hotel software buyers would prefer a web-based PMS. [16]

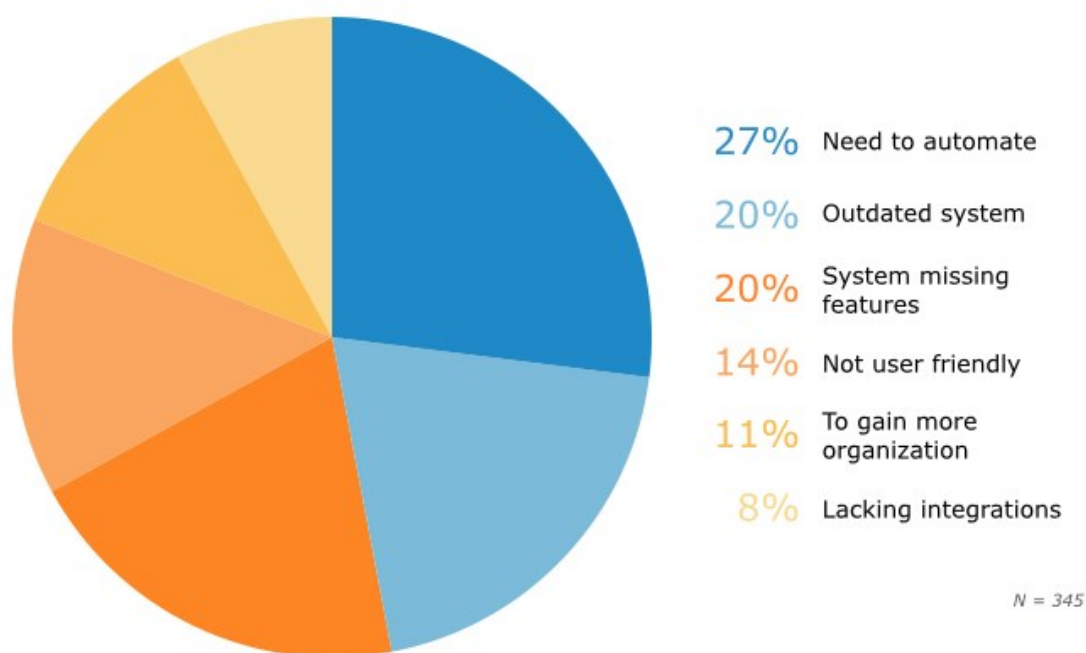


Graph 2: Preferred Deployment Options for Hotel Software [16]

PMS Market Analysis and Demographics

The need for a modern PMS

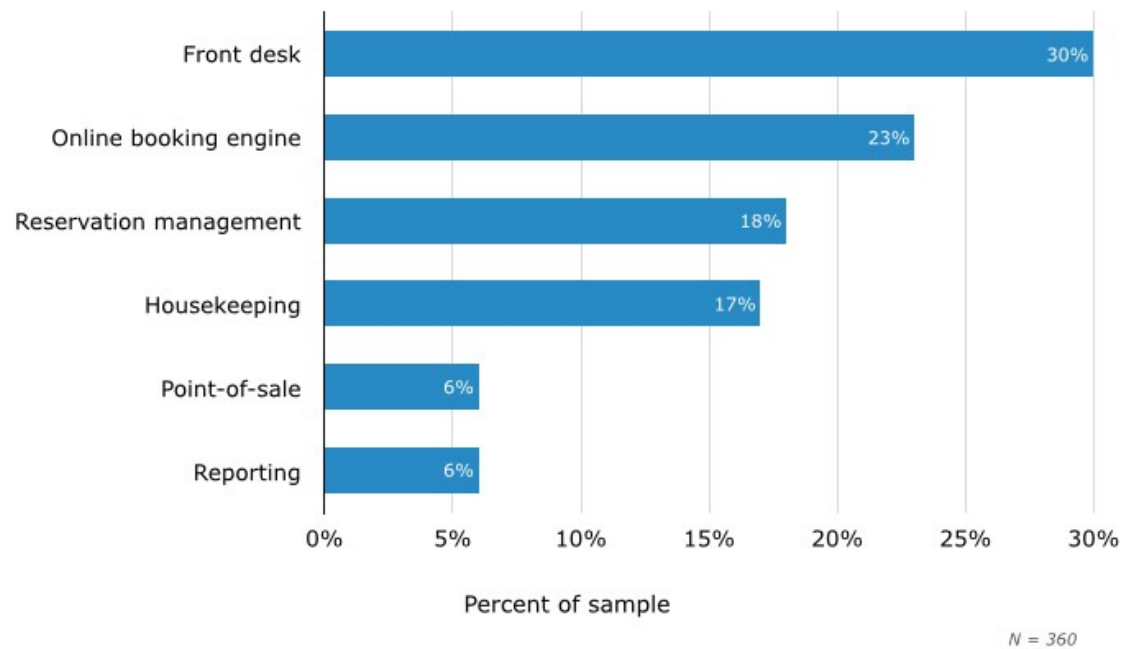
For PMS seekers, a combined 62% cite specific problems with the software – it’s old, it lacks features or it’s hard to use – as their reason for shopping around. Another 27% are just starting out and want a new system to help them stay organized from the beginning. [16]



Graph 3: Reasons Hoteliers Buy New PMSs [16]

We also looked at the applications buyers request most to find out their must-have functionality. Front desk applications, unsurprisingly, ranked first; every hotel needs proper front desk capabilities to check guests in and out and generating key cards. [16]

Beyond the basics, buyers need to make sure their hotel has an online presence that can attract guests who can book directly from the hotel’s website. It’s no surprise, then, that an online booking engine (OBE) was a close second at 23%. [16]



Graph 4: Top Requested Hotel Software Applications [16]

PMS Uptake in Hotels worldwide

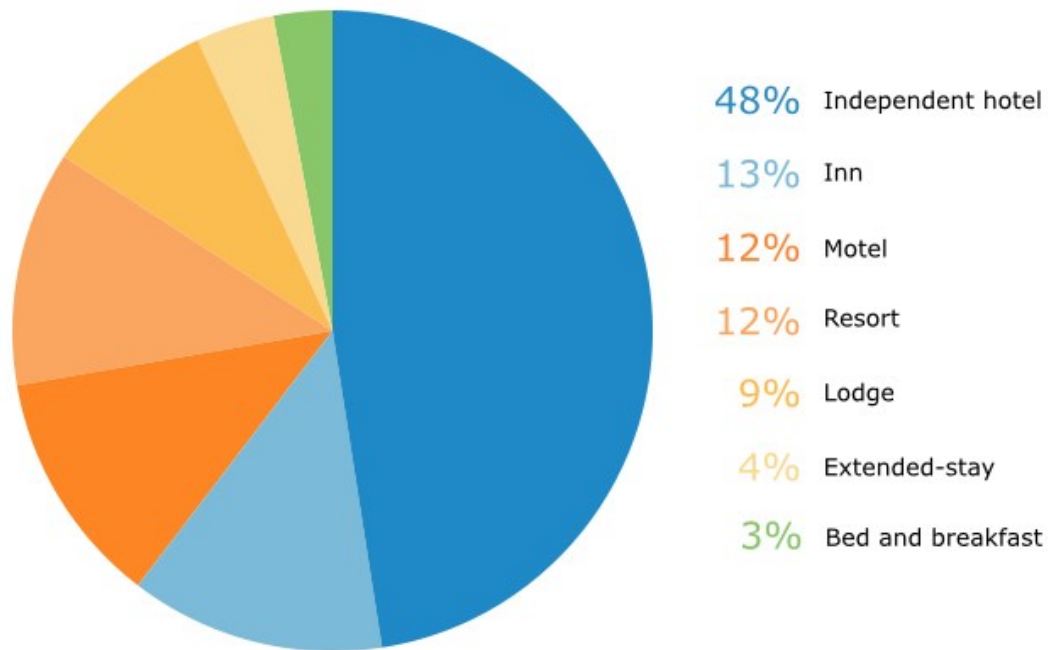
Some of the key factors that drive PMS adoption in hotels worldwide, are the following:

- **Hotel size** – Hotels with a small amount of rooms (usually less than 20) are much less likely to use a PMS and more likely to use manual methods (spreadsheets or paper based methods) to manage their bookings. In contrast, PMS penetration is close to 100% in larger units (>100 rooms).
- **Star rating and facilities** – hotels with rating less than three stars are less likely to adopt a PMS. Hotels that offer on premise amenities, like spas and restaurants, have increased needs “for management software and the efficiency benefits which technology can offer” [13].
- **Occupancy ratings** – low occupancy hotels are less likely to have invested in a PMS. In contrast, high occupancy ones have an increased need for proper work structure, provided by a PMS, automation and quite often they need to micromanage their room allocation.
- **Location** – Hotels in large tourist resorts and big metropolitan areas are more likely to make use of PMS.

PMS solutions are expected to become even more popular in the near future. One of the biggest reasons is online-booking. With the vast majority of guests preferring to book their rooms online, hotels are investing more and more in PMS solutions that integrate with channel managers, booking engines and central reservation systems.

Demographics of Hotel Management Software Buyers

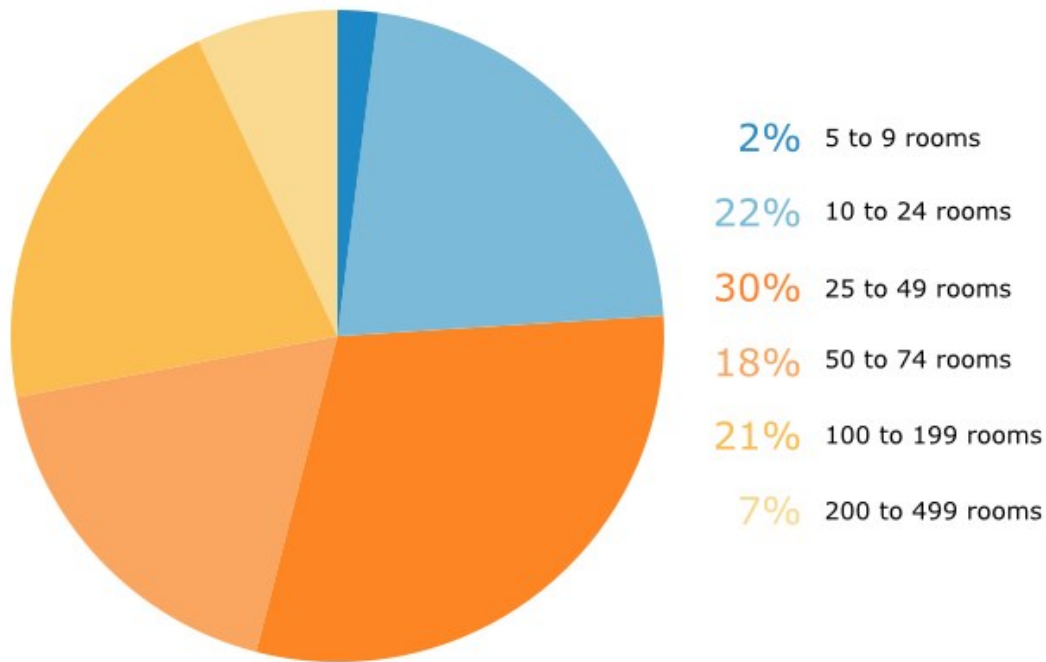
As mentioned before, 48% of respondents are from independent hotels, as compared to the remaining franchised properties [16].



N = 313

Graph 5: Type of Hospitality Company [16]

Smart hoteliers know that the younger, most lucrative traveler segments today are looking for a real experience – not just a nice guest room. This trend has spurred the increase of boutique, independent hotels across the world, designed to provide more authentic experiences. This sense of authenticity gives smaller hotels a powerful feature to stand out from large hotel chains. [16]



N = 134

Graph 6: Size of Property by Number of Rooms [16]

Key Country Profiles

The British Hotel Market

Hotel Landscape:

- Independent hotels make up 66% of all hotels [13].
- New hotel openings (forecast): 119 [13].
- Average hotel size: 46 rooms [13].
- Average size of independent hotel is 24 rooms, and average size of chain hotel is 89 rooms [13].

Current PMS penetration:

- The current penetration of PMS is c. 90% [13].

Adoption of cloud-based PMS

- Our primary research bottom-up assessment suggests that 3.905 hotels are using cloud PMS, which is 32% of the hotels market [13].
- Cloud adoption expected to grow in the next 5 years with increasing hoteliers' awareness of its benefits [13].

Competitive Environment

- Large international hotel chains and resorts targeted by Oracle Hospitality, PAR Springer Miller and Itesso or use in-house PMS system [13].
- 30-150 room hotels – generally independents and small chains – targeted by Infor, Sabre, Protel, Itesso, Hotelogix, Guestline and Opera Lite [13].
- Local and region focused players also do well – Clock, Hotel Perfect in South West, and Ihotelligence in Ireland [13].
- Small hotels (<30 rooms) – targeted by new entrants Littlehotelier, Eviivo, Avondara, Hetras and Welcome Anywhere [13].

The French Hotel Market

Hotel Landscape:

- Independent hotels make up 77% of hotels [13].
- New hotel openings: 86 hotels with 15.281 rooms [13].
- Average hotel size: 36 rooms [13].
- Average size of independent hotel is 25 rooms, and average size of chain hotel is 80 rooms [13].

Current PMS penetration:

- The current penetration of PMS is c. 75% [13].
 - Highest in the >100 rooms bracket, where it is close to 100% [13].
 - It is much lower in the <20 room bracket c. 50% [13].
- Uptake of PMS is higher in urban areas and would be highest in the Ile de France (Paris) region [13].

Adoption of cloud-based PMS

- The current penetration of cloud and cloud-hybrid PMS is estimated at c. 10-15% [13].
- Hybrid cloud solutions have gained more traction than pure cloud as hotels prefer back-up of server and there are more hybrid versions available on the market [13].
- Shift to cloud should accelerate in coming years – cloud-PMS expected to account for 20-25% of PMS systems in 3 years' time [13].

Competitive Environment

- Oracle, Protel and Itesso focus on larger hotels [13].

- Along with Infor, French national players target the 20-100 room hotels and have high awareness – Quatuhore (Vega), Sequisoft/Cegid, Medialog, Topsy and Fiducial [13].
- Pure cloud players also targeting this segment – Misterbooking, Conservus, ThaisSoft [13].
- The micro segment is targeted by more basic cloud offerings from players which include Eviino and Familyhotel [13].

The German Hotel Market

Hotel Landscape:

- Independents make up 89% of hotels [13].
- New hotel openings: 554 hotels with 77.142 rooms [13].
- Average hotel size: 28 rooms [13].

Current PMS penetration:

- The current penetration of PMS is c. 60-70% [13].
 - Highest in the >100 rooms bracket, close to 100% [13].
 - It is much lower in the <20 room bracket, with higher uptake in the medium sized hotels [13].

Adoption of cloud-based PMS

- The current penetration of cloud (web native PMS) is estimated at less than 10% [13].
- Hybrid cloud solutions have gained some traction as players targeting larger hotels – Oracle and Protel, have developed a hosted solution and moving chain hotels to it [13].
- Shift to cloud is not expected to accelerate at the same rate as in other EU countries in the short to medium term, although some smaller players expect a shift in the next replacement cycle [13].

Competitive Environment

- Oracle targets larger hotels and chains [13].
- Protel also targets some larger hotels, but focuses on the mid-tier (c. 100 rooms) [13].
- Infor targets chains, larger and mid-tier hotels [13].
- Local German players target the mid-market – Protel, Gubse, Hetras (mid-size chains with up to 150+ rooms) [13].
- Protel (with Protel Air) and Hetras also target the 20-30 room hotels. Cloud players targeting the micro segment (5-10 rooms) include

Adelpha and Enmuse. Some hotels may use PMS functionality provided by their distribution channel. [13]

The Italian Hotel Market

Hotel Landscape:

- Independents make up 96% of hotels and 87% of rooms [13].
- New hotel openings: 81 hotels with 10.301 rooms [13].
- Average hotel size: 33 rooms [13].

Current PMS penetration:

- The current penetration of PMS is c. 70-75% [13].
- PMS uptake is higher in urban areas, especially in major tourist destinations – Rome, Venice, Milan, and Florence [13].
 - Highest in the >100 rooms bracket, close to 100% [13].
 - Much lower in the <25 room bracket [13].

Adoption of cloud-based PMS

- PMS penetration is expected to grow to 80% over the next three years, driven by cloud adoption, growth in online bookings, increasing IT proficiency of hoteliers and further development of internet infrastructure [13].
- The current penetration of cloud and hybrid-cloud PMS is estimated at c. 10% and expected to grow to 15-20% over the next three years – most providers offer cloud, and most PMS replacements are for cloud [13].
- Hybrid cloud solutions have gained more traction than pure cloud as smaller (<100 rooms) hotels favour local backup servers [13].

Competitive Environment

- Oracle targets larger and high-end (4/5*) hotels and chains, as do Protel [13].
- Local Italian players target the mid-market – GP Dati (Scrigno), Ericsoft (Hotel 4o), Gestione Albergo (Leonardo Hotel), HQ Soft (Horizon Accommodation), and Passepartout (Welcome) [13].
- NI.CE. Informatica and 5stelle target the <25 rooms size band [13].

The US Hotel Market

Hotel Landscape:

- Independents make up 66% of all hotels [13].

- New hotel openings: 1.347 hotels with 286.882 rooms [13].
- Average hotel size: 94 rooms [13].
- Non-branded hotels have a higher presence in luxury and economy class accommodation [13].

Current PMS penetration:

- The current penetration of PMS is c. 75-85% [13].
 - Highest in the 50+ rooms bracket, where it is greater than 90% [13].

Adoption of cloud-based PMS

- The current penetration of web-native PMS is estimated at c. 10-15% with another c. 15-20% of hybrid solutions [13].
- PMS providers frequently segment the market by star rating rather than room-size [13].
- Shift to cloud should accelerate in coming years – web-native PMS expected to account for 30-50% of PMS systems in five years' time [13].

Competitive Environment

- Oracle targets 4/5* market. Also offers Oracle Express and Oracle Lite to target lower-end customers [13].
- Infor's cloud PMS can be expanded to a full ERP (Enterprise Resource Planning) solution. Targeting large 4/5 star hotels. Its key strength is richness of functionality, particularly around revenue management. [13]
- PAR Springer Miller has full featured on-premise solution with deep integration to target large hotels and pure cloud solution to target <150 rooms market [13].

Leaders in the PMS market

The following charts show the leading PMS solutions in the market:



Figure 9: PMS Chart [21]

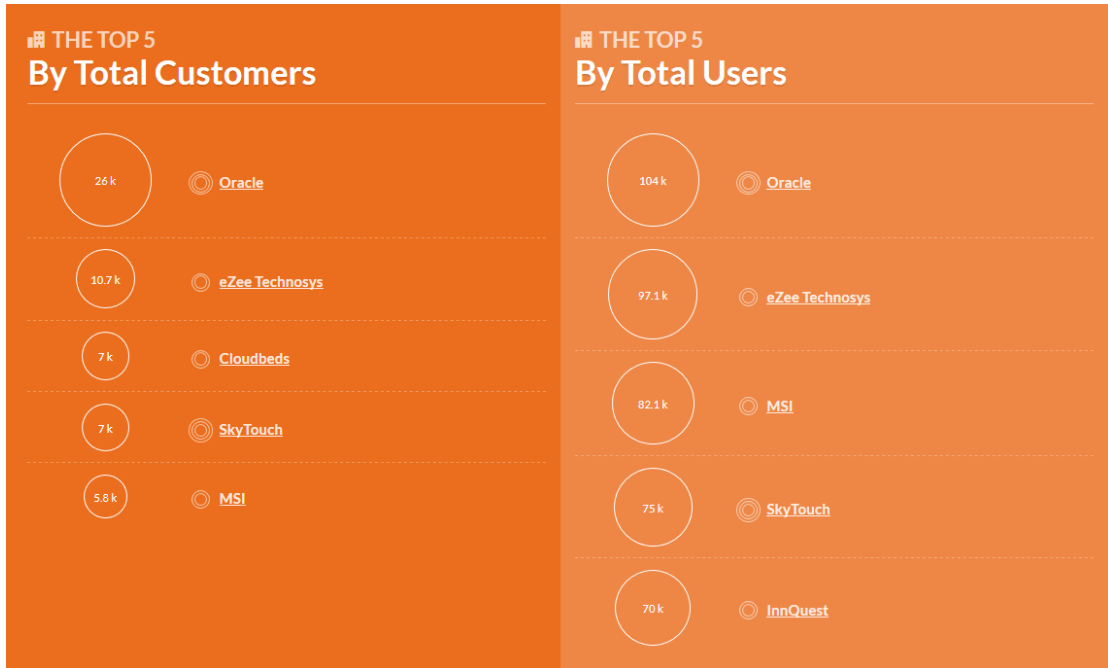


Figure 10: PMS Top 5 [21]

PMS Product	Catering	Employee Management	Front Office Management	GDS/OTA Integration	Group Management	Guest Experience	Housekeeping - Maintenance	Marketing Management	Multi-Property	Online Booking	Point of Sale (POS)	Reservations Management	Reviews Management	Cloud-based
Oracle	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
eZee Technosys	-	-	✓	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	-
SkyTouch	✓	✗	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓
MSI	✓	✗	✓	✓	✓	✗	✓	✗	✓	✓	✗	✓	✗	✓
InnQuest	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓
Cloudbeds	✗	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓
Hotelogix	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓
Cubilis	✗	✗	✓	✓	✓	✓	✓	✗	✓	✓	✗	✓	✓	✓
Frontdesk Anywhere	✗	✗	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓
Guestline	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Innkey PMS	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓
GuestTracker	✗	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
WebRezPro	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓
Sirvoy	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗	✓
RDP	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓
DJUBO	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓
Hotello	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BookingCenter	✗	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓
Base7booking	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓
Percent Having Feature % (*)	33.3	44.4	94.7	100	100	84.2	94.7	73.7	100	100	84.2	100	68.4	100

Table 1: Features of leading PMS products.

PMS market leaders' summary

It is evident that software giants such as Oracle, dominate the global market and provide the most feature rich platform, mostly for hotel chains and enterprises. This is no surprise really, considering the company behind this software and the time they have been active in the hospitality business.

We also see several other PMS solutions in the top spots, from long-standing players in the industry such as eZee technologies, MSI and Innkey.

Newer, cloud-native PMS are also present in the top spots like Cloudbeds, which launched no more than 5 years ago. An impressive feat no doubt, considering that it is still a relatively new solution.

More cloud-native PMS are also starting to appear in these lists, like front desk anywhere, Base7Booking and others.

This trend is expected to increase in the coming years, as more new cloud-native solutions are being developed and existing ones mature and become more feature-rich.

Booking channels

The following chart (courtesy of siteminder.com) shows the leading booking channels for the Greek market:



Figure 11: Most Popular Online Travel Agents [22]

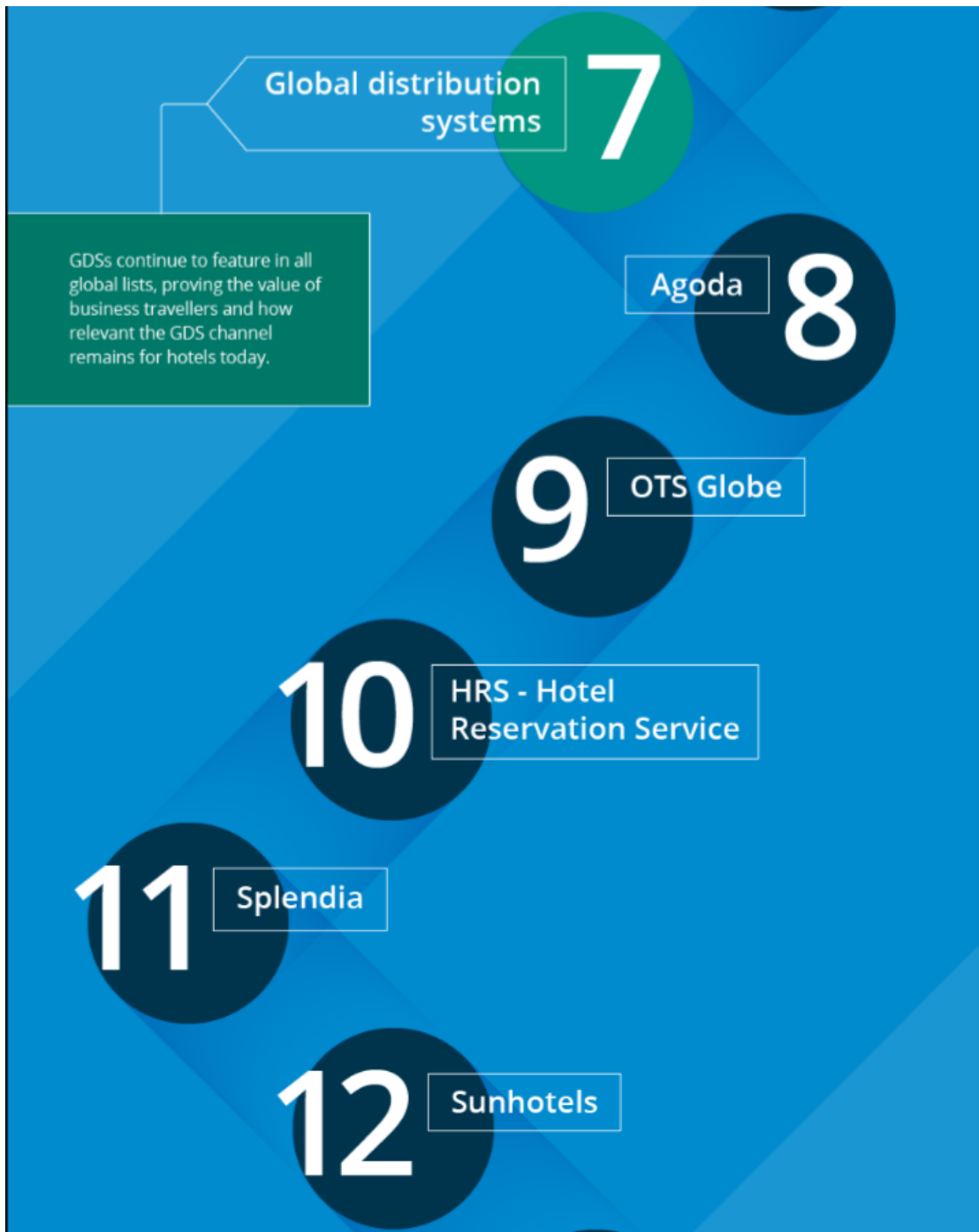


Figure 12: Most Popular Online Travel Agents (cont.) [22]

Design & Development of a Cloud-native PMS

Introduction

Based on the previous chapter, it is evident that there's no shortage of PMS solutions in today's market; each one with its own strengths, weaknesses and target audience.

There are many on premise solutions, mostly software from the previous decade, that has had the necessary time to develop into enterprise solutions, aimed mainly at large hotels and hotel chains.

Newer software is almost exclusively cloud-based and is generally targeted at smaller to mid-sized properties.

One has to keep in mind, however, that the market for such software is huge and there will always be room for more solutions. Especially quality ones.

Being employed at a property management company, I have come across and used several PMS solutions (mostly older ones, as the Greek market and the hotel industry in general, aren't known for their rapid adoption of new technologies) and I'm aware of their shortcomings. Some of these include:

- Not user friendly
- Outdated design
- Feature bloat
- Slow performance
- Not designed for multi-property management
- Deployment hassle
- Poor or no documentation
- No mobile device support

In my line of work, I have spent more hours than I should have, troubleshooting deployment issues, software or database upgrades, licensing problems and other issues related to on premise solutions.

I have lost many work hours due to slow application performance, slow database access and software generally requiring more steps than necessary to get simple things done.

Many more work hours over the phone going over new bookings, arrivals and departures, because of the lack of mobile device access.

Finally, even more hours explaining how features work due to the lack of a user friendly interface, documentation or no localized documentation/support. This is especially true for less tech-savvy users, having to find their way through many menus and features that they don't really need to have access to.

Even I have found it either hard or time-consuming producing reports and statistics, especially for multiple properties at once.

Based on my described experiences, I decided to develop my own solution.

Following the trend of cloud-based PMS solutions, I'm in the process of developing a PMS from scratch, aimed, like most modern systems at their conception, at smaller to mid-sized properties, with features that make it easier to manage a single or more properties at once.

Tools & Technologies Used

The technologies I am using to develop this software are:

- HTML5 for markup
- CSS3 for styling
- JavaScript as a client-side programming language
- PHP as a server-side programming language
- MYSQL for my database needs
- AJAX for client to server requests

Being a beginner in web-development and interested in future investment in this field, I opted out of using technologies with additional abstraction layers (i.e. frameworks). This choice has offered me a greater understanding of what I am doing and has allowed me to have more control over my code. It is certainly easier to troubleshoot when there is no automatically generated or hidden code by a framework and you have written every line of code.

The downside to this, at least from an experienced web-developer's point of view, is development speed. However, since I'm not an experienced web developer, I believe the use of a framework would be a little benefit (if not a detriment) to me.

For the purpose of this project, I'm making use of only one external library, [chart.js](#), an open source JavaScript library for producing and displaying charts using the HTML5 canvas.

Finally, I'm using an open-source text-editor, called [Atom](#), to write code and manage my project.

Project Overview

For the purpose of this thesis, the following modules were developed for this PMS solution:

- Dashboard, where the end-user can have a quick overview of the daily happenings of a property, such as arrivals, departures, the latest actions performed by the property's staff and an occupancy chart for the next seven days.
- Calendar or reservations chart, where the end-user will be able to keep record of all the reservations in a property, add new ones, edit existing reservations and make cancellations, for a selected time period.
- Rates, where the end-user inputs the property's rates and various contracts signed, for the purpose of allowing the calendar module to calculate prices automatically and provide pricing to the booking engine and to connected OTAs.
- Customers. A comprehensive customers' module, which displays a list of all customers and detailed information in a customer-card view, along with a list of reservations made for each one.
- Reports. Here, the end-user can view several reports and statistics related to the property's operations.
- Logs. A list of all actions performed by the hotel staff can be found here, for the purpose of keeping track of the changes made across several modules of the PMS.
- Users. This page allows the end-user to maintain a list of users that will have access to the PMS, each one within its own credentials and permissions, based on user type.
- Settings. The settings page consists of multiple sub-pages that allow the configuration of the PMS modules and setting up the property.
 - Room setup. This is where the amount of rooms and room types of the property are configured.

Project Structure

File structure

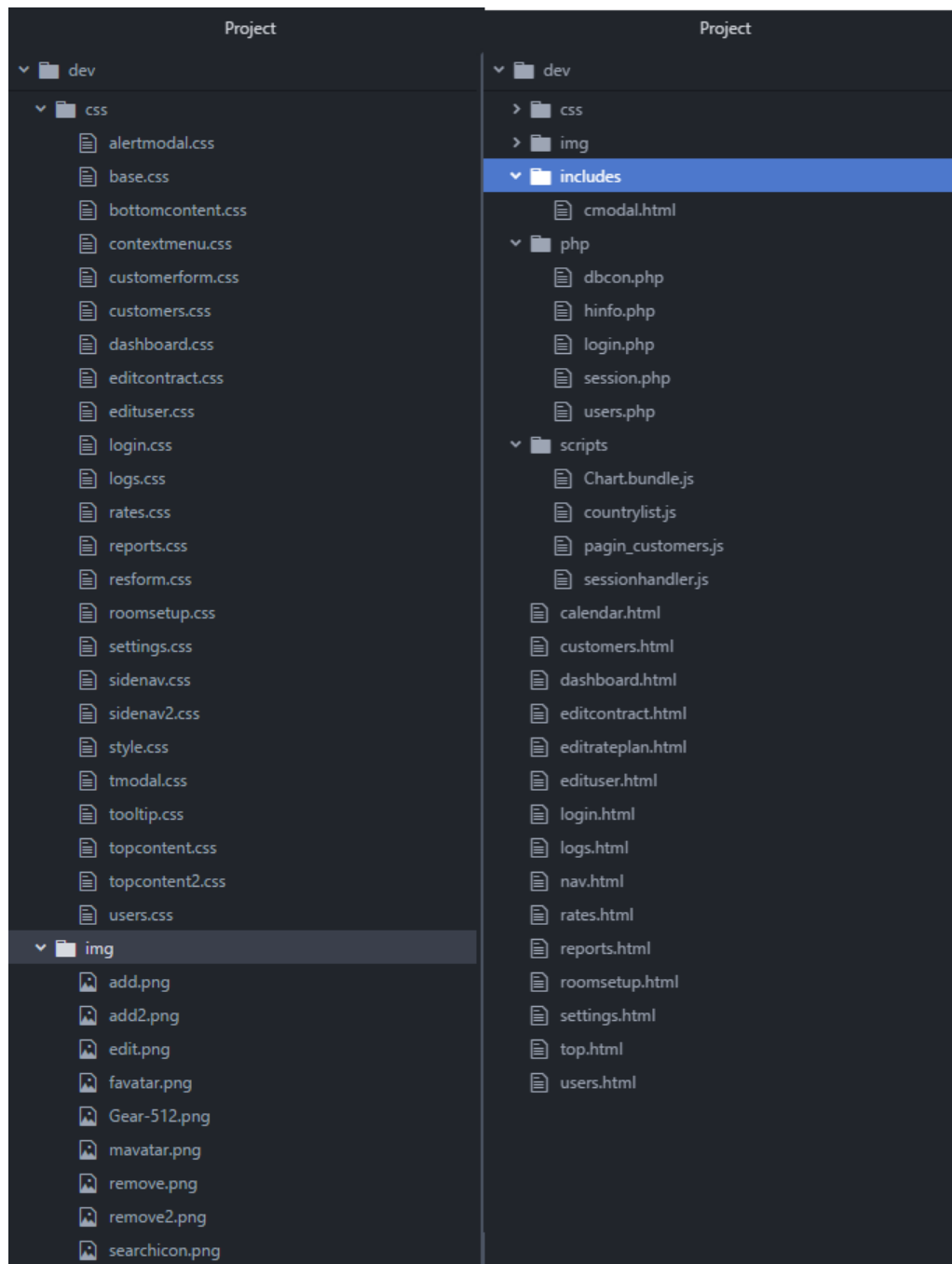


Figure 13: Project file structure

The project consists of several file types, like html, css, php and scripts. The main ones are the html files, where each one represents a different page (module) of the PMS, with exception of some files, like the application's navigation menu(nav.html), top content (top.html, where hotel and user info

is displayed) which are included in every page, along with the `cmodal.html`, included in the calendar and customer modules.

The CSS files are used to control the way the different modules of the PMS are styled and displayed. Each module is linked to one main stylesheet, which controls the overall page layout and usually several more which control the styling of a page's sub-modules. A lot of CSS files are reusable over multiple pages a few of them are used in all of them, providing a basic style and "feel" across the whole application.

Javascript files include code reused over several pages, like session data being communicated from the server to the browser, pagination control, a country list used to populate dropdown menus and the external library `chart.js` used to create and display charts.

PHP is used for client-server communication. `Login.php` handles login requests through the logon page. Upon successful logon, `session.php` is called to create a new browser session for the active user and assign active databases to the session. For every client operation that requires data to be recorded, modified or deleted, `dbcon.php` is called to modify the database accordingly. `Users.php` is used when modifying the user list and handling user permissions across the application.

Finally, browser cookies are utilized to store application settings across browser sessions.

Database Design

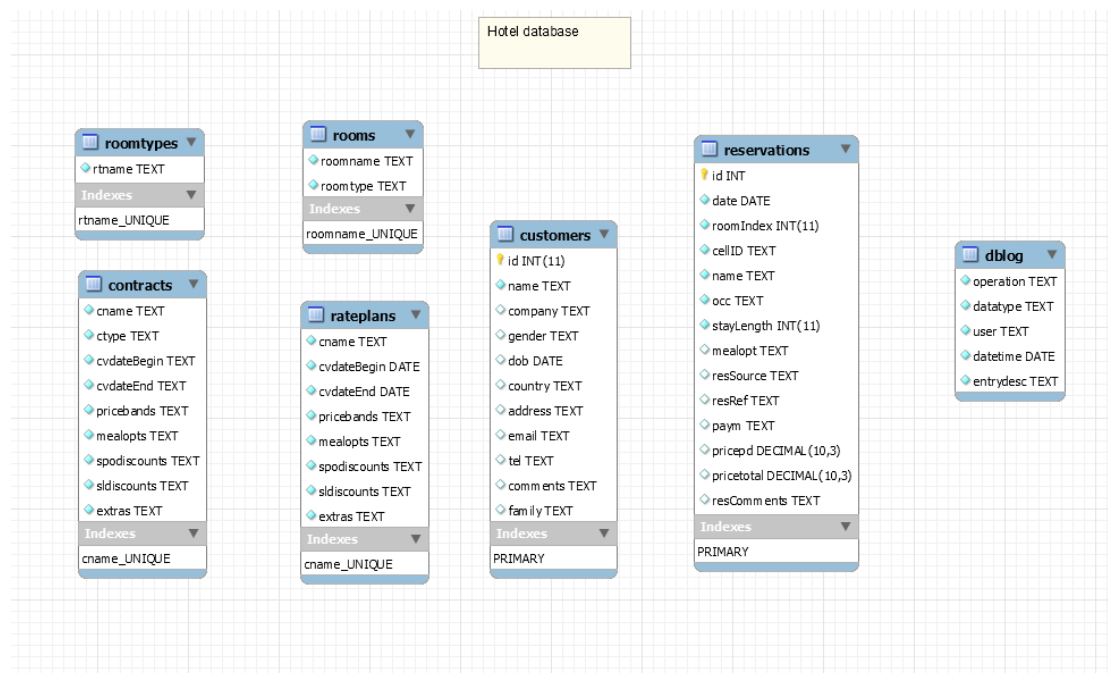


Figure 14: Property database structure - EER diagram

In Figure 14, the structure of a hotel's database is displayed.

One more database is used to store all the different users from all hotel databases and assign each one to have access to one or more properties and finally, a database to store all hotels, along with some important details about them, like the primary user (owner), number of rooms, resort, property type and more.

Module Analysis

In this chapter, I provide a detailed analysis of each PMS module, along with parts of the creative process behind it.

Logon Page

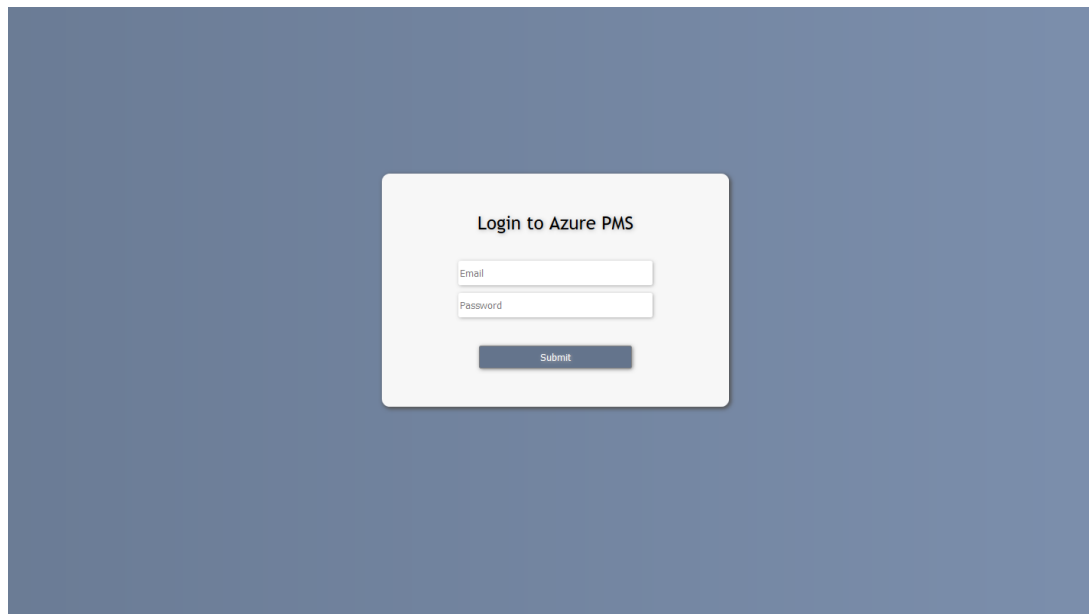


Figure 15: Application's logon page

Upon navigating to the application's url, the user is greeted with a logon screen, as seen in the above figure.

The user credentials entered here, tell the application which property's database or databases to utilize for the purpose of this browser session. Each user has been assigned one or more properties he or she can access.

The server validates the information entered in the form and upon successful logon, the browser session is initialized by the server and the user is redirected to the landing page of the application.

Dashboard

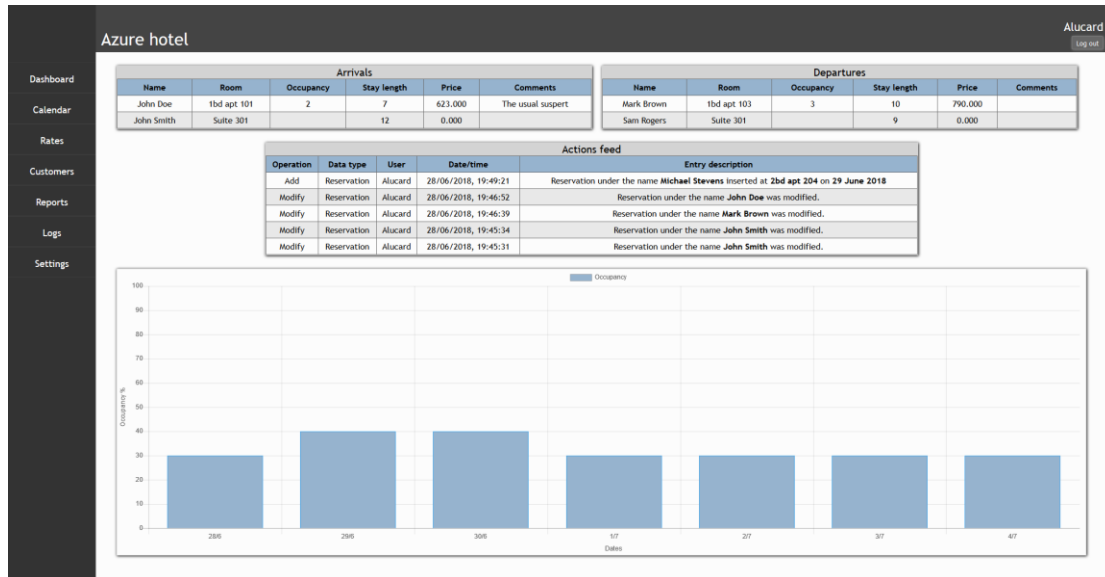


Figure 16: Dashboard

The dashboard is the application's landing page, after logon. In this page, the user can quickly glance at what is happening at any given day or time at a property.

A list of arrivals and departures are shown for the current day, along with some info as to which room will be occupied or freed, the price of the reservation, length of stay, as well as notes made for these reservations.

The actions feed, allows users to view the latest actions performed by all users, such as added reservations, cancellations, customer check-ins and more. Reservations made through the booking engine may also appear in this feed.

Finally, an occupancy percentage chart is displayed for the next 7 calendar days.

This page could be expanded, beyond the scope of this thesis, by including the latest in-app customer communication, more chart options, such as daily revenue and more.

Calendar

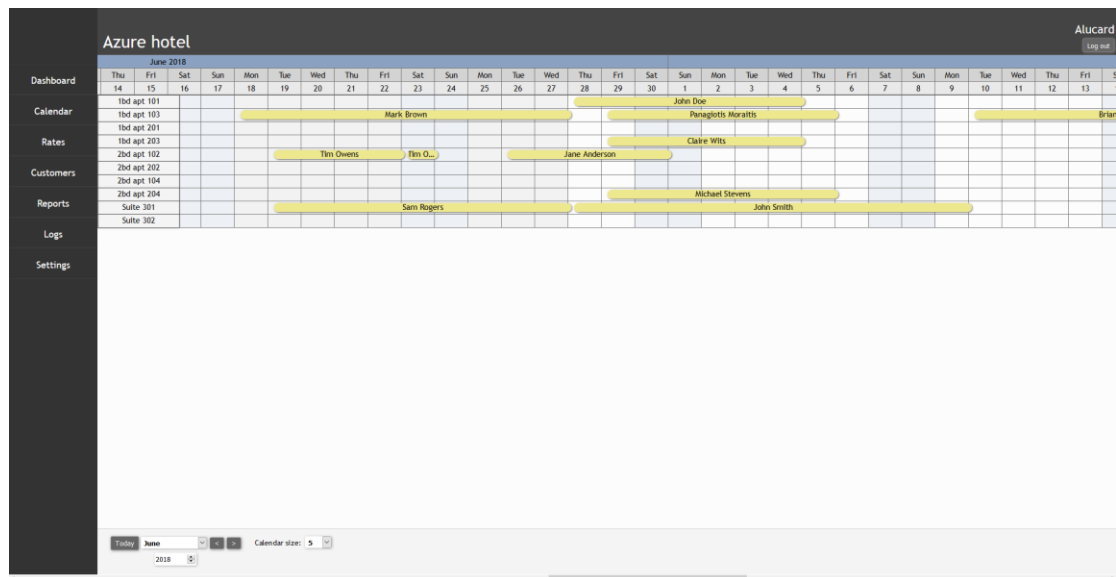


Figure 17: Calendar

The calendar will be the page the end-user will spend most of their time on. This page allows users to work with reservations. Through the calendar, they can view existing reservations, add a new one, modify existing ones or make cancellations.

It is also the page that I spent most my development time on. I firmly believe that the A and Z of a good PMS solution is a powerful, user friendly and modern looking calendar.

The calendar in this PMS solution was developed from scratch, with a little design inspiration, of course, from existing PMS solutions.

When conceptualizing this application, I had a very brief look at existing calendar-like applications on the web, but I quickly realized that PMS require custom made calendar solutions. Generic calendars will simply not work in any satisfactory manner.

Quite a bit of work went into coding the basics of a calendar, like building the basic functions of how many days there are in each different month, taking leap years into account, days of the week, how new dates and months are added as the user scrolls left or right, in order to provide a seamless transition from each period to the next and generally building the core logic of this module.

I also spent a lot of time styling it with CSS and fine-tuning how everything looks and feels.

Each column in the calendar, represents a single day and the calendar can span up to a maximum of nine months. Each row represents a room in the property. The user can insert a reservation into a row (room) that can span into several columns (days), as shown in the below figure:

July 2018															
	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	
	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1bd apt 101					John Doe										
1bd apt 103															
1bd apt 201															
1bd apt 203															
2bd apt 102															
2bd apt 202															

Figure 18: Reservation

When hovering over a reservation, a tooltip with some quick info about it appears.

July 2018															
	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	
	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1bd apt 101					John Doe										
1bd apt 103															
1bd apt 201															
1bd apt 203															
2bd apt 102															
2bd apt 202															
2bd apt 104															

Check-in: 15/07/2018
 Check-out: 22/07/2018
 Occupancy: 2 adults
 Supplement:
 Price: 623.000
 The usual suspert

Figure 19: Reservation tooltip

The user can view different dates by scrolling left or right, or by using the controls on the bottom left, to jump straight to a specific month and year or even scrolling one month at a time, using the arrow buttons.

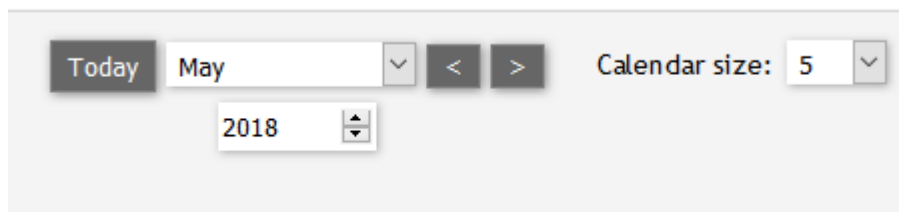


Figure 20: Date Controls

When a user chooses to add or edit a reservation, the reservation popup window appears:

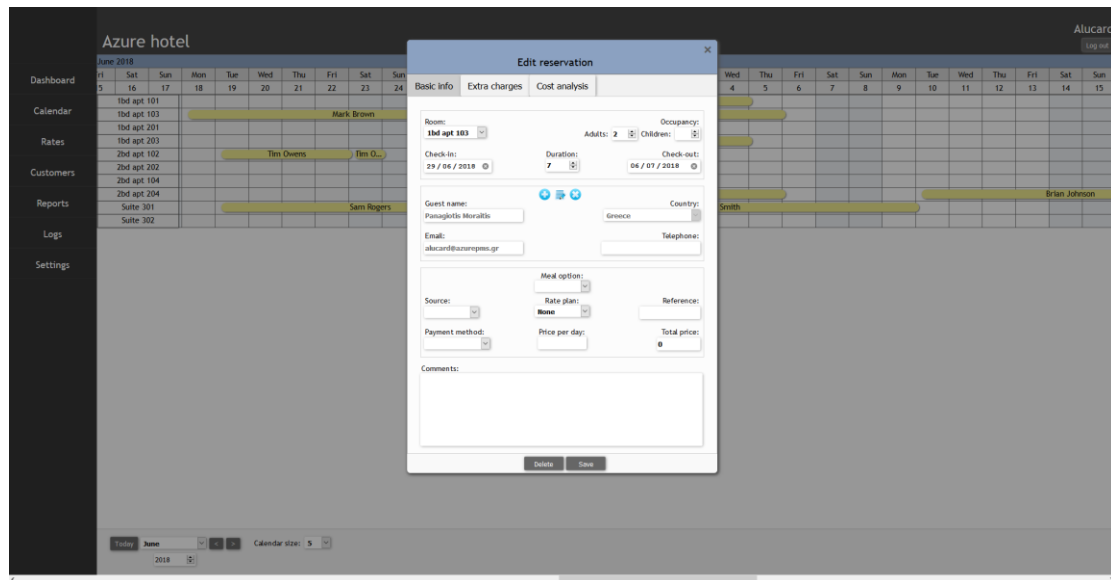


Figure 21: Reservation Window

The reservation window consists of three tabs.

Basic Info Tab

In the “Basic info” tab, there are three main control groups. There’s also a meal option dropdown menu and a comments section.

In the first group (room), users can choose the room type, specify the room occupancy, as well as the check-in and check-out dates.

In the next control group, the users can add or edit the guest’s name, nationality, email address and phone number. In addition, the user can select an existing guest, taken from the suggestion box when typing, which is populated from the customers list, change the guest’s information, or, if they want to fill in more details, they can open the customer window, shown in figure 27, from within the reservation.

In the last control group, users specify the meal supplement that the guest has chosen with his reservation, the source of a reservation, its’ reference number, payment method and price it according to a specific rate plan or by using a custom price. can

Lastly, in the comments section, the user can enter a customer’s request or add a comment about the client or the reservation.

Extra Charges Tab

In the extra charges tab, users can add additional charges (e.g. charges from the mini bar, the pool bar etc.), which add up to the total price of the reservation. This makes it easy to produce a single receipt or invoice for the stay of the customer.

Cost Analysis Tab

This tab provides a breakdown of the cost of the reservation. The cost is broken down to room cost, meal supplements, extra charges and tax.

Rates

The purpose of this page is to provide the user with an intuitive and user-friendly way of recording and managing a property's various pricing plans and contracts signed.

These records are then used to provide automatic rate calculations to the calendar module, as well as provide rates to the booking engine module and could also push rates to connected online travel agents.

Rate plans

Rate plan name	Valid from	Valid until
Standard rate	2018-04-20	2018-10-31
Non refundable	2018-04-20	2018-10-31

Contracts

Contract name	Valid from	Valid until	Contract type
No contracts loaded			

Figure 22: Rates page

In Figure 22, we can see the main page of this module, listing all the contracts and rate plans recorded for this property. From this page, the user can choose to create new entries, edit or delete existing ones, by right clicking on a record.

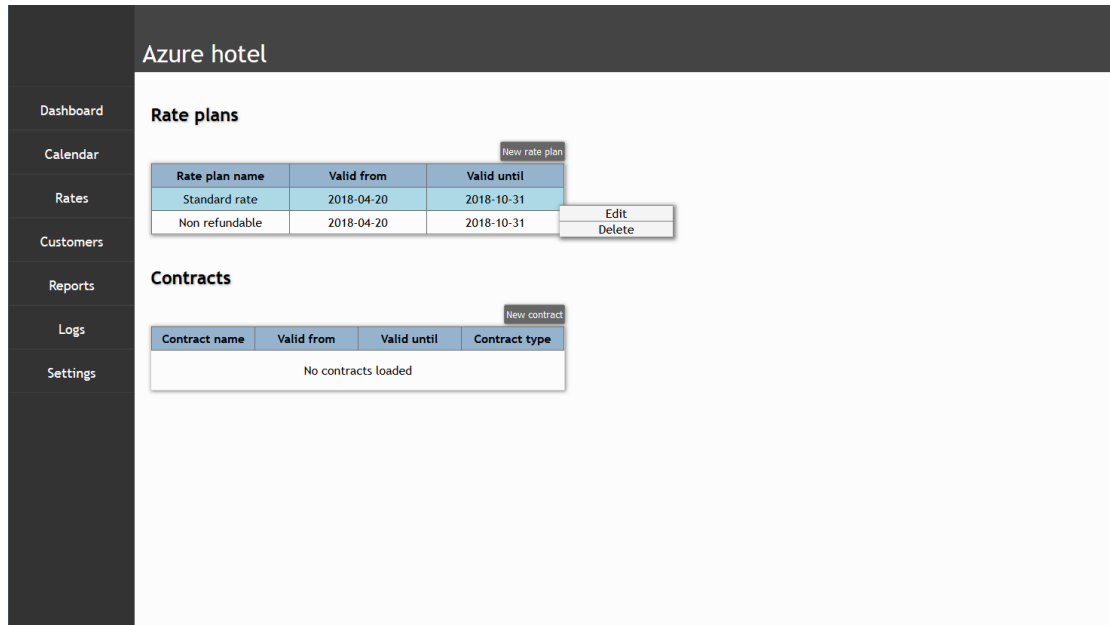


Figure 23: Context menu

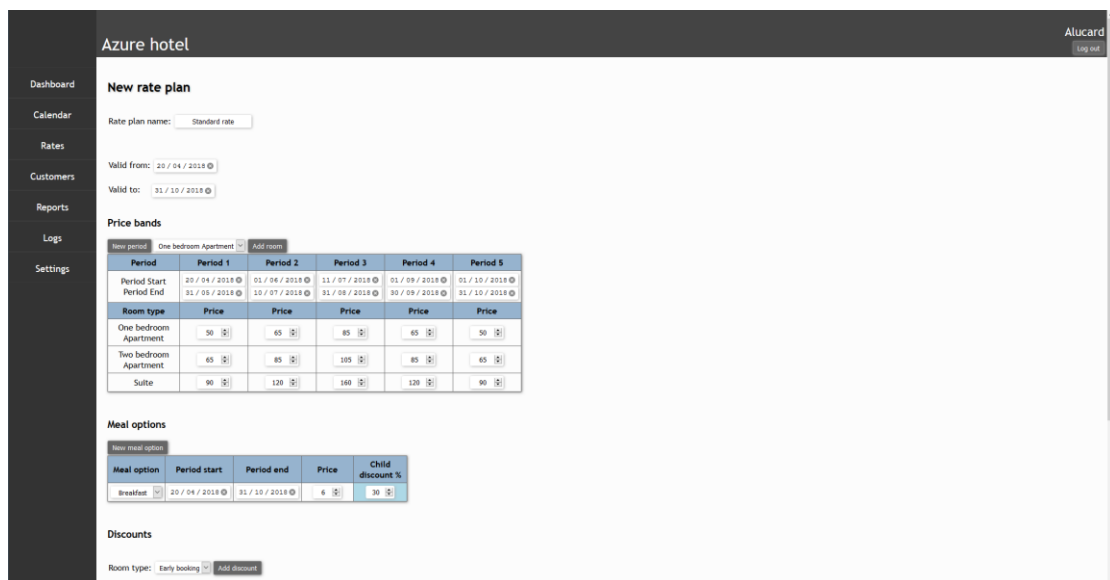


Figure 24: Contract edit page

The page where the user can record the details of a rate plan or contract is shown in figures 24 and 25.

The user is first asked to enter some basic information, such as the contract name, contract type, allotment or guarantee and the contract's valid dates.

In the price bands table, the user is asked to enter the room prices for several time periods. Each column in the price bands table represents a different time period and each row is a different room type. The user is free to enter as many or as few time periods as needed. The same is true for room types.

In the meal option table, the user can specify the price of meals, if offered by the property, and the time period that they are available for purchase (i.e. many properties operate as room only during the off season). Providing a child discount is also an option. The available meals types are: Breakfast, Half-board, Full board and All-inclusive.



Figure 25: Edit contract page

In the discounts group, the user can specify discounts for specified time periods.

A common type of discount is the early booking discount. If a customer makes a reservation early on in the season, he is offered a discount.

Another common type of discount is based on the number of days booked. If a customer books a specific number of days or more, he receives a discount.

Lastly, the user can specify the prices of room extras, such as air conditioning, safe box usage etc.

Customers

ID	Name	Country	Email	Phone
176	John Doe	United Kingdom	john.doe@azurepms.gr	
177	Mark Brown	United States	markbrown@azurepms.gr	
178	John Smith	United States	johnsmith@azurepms.gr	
179	Sam Rogers	United States	sam@azurepms.gr	
180	Jane Anderson	United Kingdom	janeand@azurepms.gr	
181	Michael Stevens	United States	ms@azurepms.gr	
182	Panagiotis Moraitis	Greece	alucard@azurepms.gr	
183	Tim Owens	United Kingdom	owens@azurepms.gr	
184	Claire Wits	United Kingdom	cw@azurepms.gr	
185	Brian Johnson	Australia	brianj@azurepms.gr	

Figure 26: Customer list

This page displays a list of customers which have made a reservation in the property. Users are able to search for a specific customer, add a new one, edit or delete existing ones. Double clicking on an entry in the list, opens up the customer card, where more details about the customer are visible.

Customer ID: 182

Name: Panagiotis Moraitis

Company:

Gender: Male Female

Date of birth: / / 1999 Age: Country: Greece

Address: Email: alucard@azurepms.gr Telephone:

Comments:

Details Save

Figure 27: Customer detail window

The popup window consists of three tabs. In the first tab, “Main Info”, users can add or change the guest’s personal information, such as name, company, gender, date of birth, country of origin and their contact information.

They also have the option to upload a profile picture to the server.

In the second tab, “Family”, users can add, edit or remove the guest’s family members and their basic information.

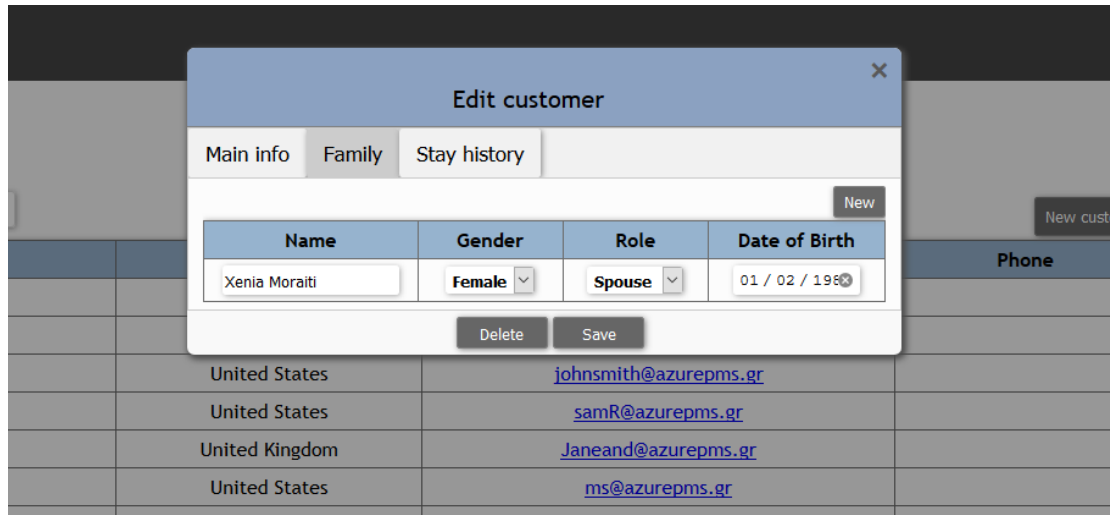


Figure 28: The family tab

Finally, in the third tab, the user can view the past stays of this particular customer in the property.

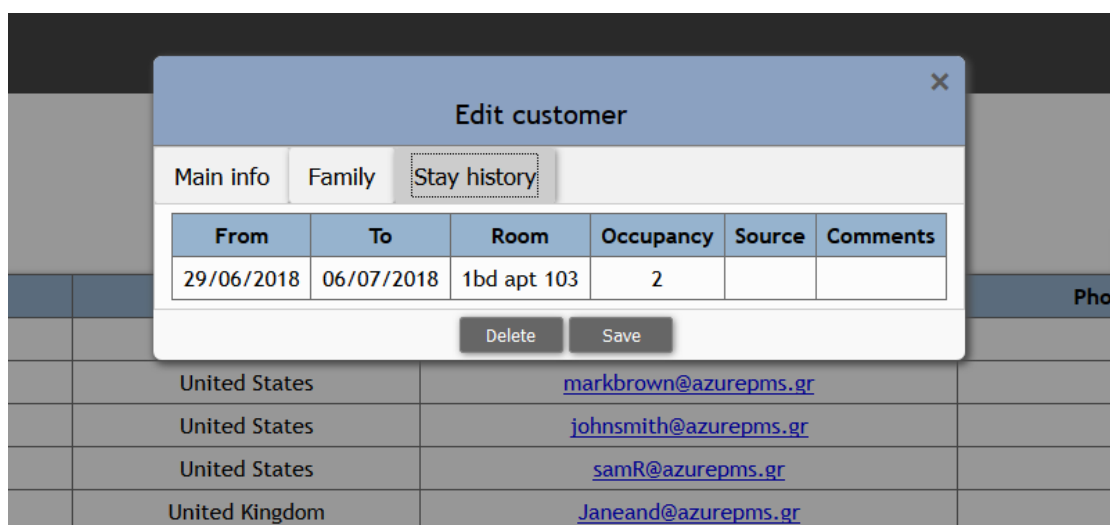


Figure 29: The stay history tab

This section could be expanded, beyond the scope of this thesis, to include customer-specific settings, such as a special discount and in-app customer communication.

An interesting coding challenge I faced on this page, was that I wanted to make the customer detail window an external file, to be injected on runtime into the page by the server, since I needed to re-use the same window on the calendar page and writing the same code in different places, was out of the question. If I had done that and later needed to make a change to this window, I would have to modify both pages. Making the customer window an external file took more work initially, but it amounts to better design practices and less work in the future.

Reports

In this page, the user can find detailed statistics regarding several aspects of a property.

The user can select a report type from the list and then the date period for which to display statistics.

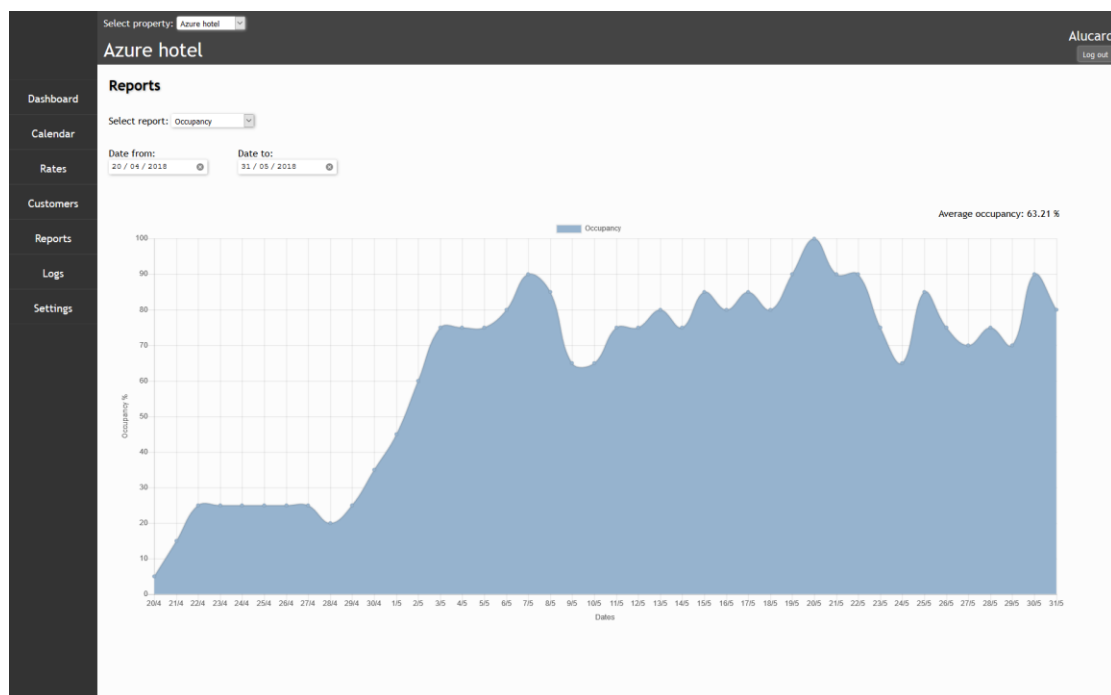


Figure 30: Occupancy chart

The first chart, shown in Figure 30, is the occupancy chart. Each data point in the chart represents a specific date. In the x axis are the dates and in the y axis is the occupancy percentage. In the top right, above the chart, the average occupancy is displayed for the selected time period.

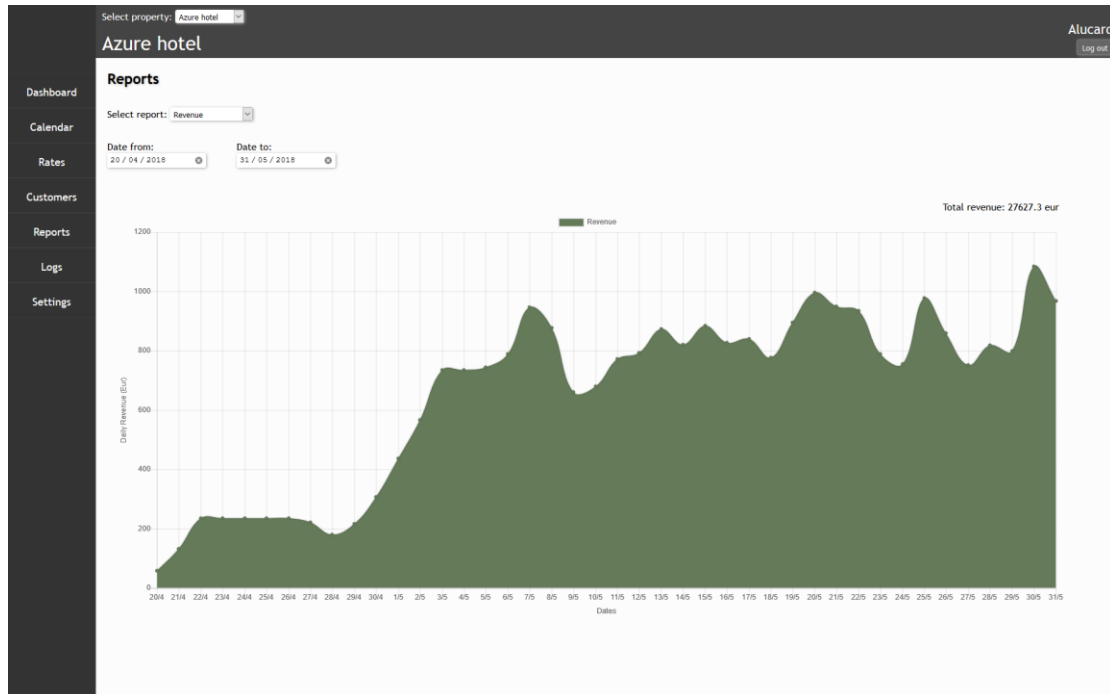


Figure 31: Revenue chart

The second option is the revenue chart. For the specified time period, the daily revenue is being displayed, along with the total revenue in the top right, above the chart.

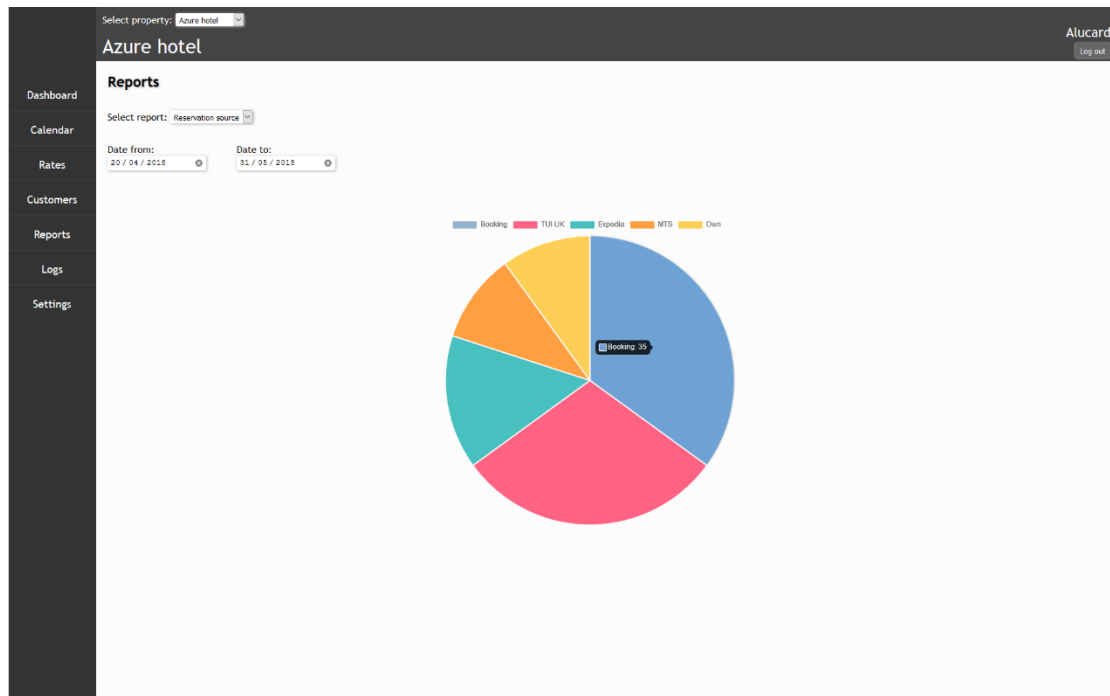


Figure 32: Reservation source pie chart

The third option is a pie chart, in which each slice represents what percentage of the total reservations come from a specific tour operator or online travel agency. The property's own reservations also have their slice.

This page could be expanded with more charts and also different display options for each chart (i.e. yearly revenue, occupancy etc.).

Logs

The screenshot shows the 'Logs' page in the Azure hotel system. The page header includes 'Azure hotel' and 'Alucard' with a 'Log out' button. The left sidebar contains navigation options: Dashboard, Calendar, Rates, Customers, Reports, Logs, and Settings. The main content area displays a table of logs with the following columns: Operation, Data type, User, Date/time, and Entry description. The table contains 25 rows of log entries, each detailing a specific system action.

Operation	Data type	User	Date/time	Entry description
Add	Rate plan	Alucard	28/06/2018, 22:30:58	Rate plan Non refundable was inserted.
Add	Rate plan	Alucard	28/06/2018, 22:29:59	Rate plan Standard rate was inserted.
Modify	Reservation	Alucard	28/06/2018, 20:32:27	Reservation under the name John Doe was modified.
Modify	Reservation	Alucard	28/06/2018, 20:32:23	Reservation under the name John Doe was modified.
Modify	Reservation	Alucard	28/06/2018, 20:32:17	Reservation under the name John Doe was modified.
Modify	Reservation	Alucard	28/06/2018, 20:32:03	Reservation under the name John Doe was modified.
Modify	Reservation	Alucard	28/06/2018, 20:25:48	Reservation under the name John Doe was modified.
Modify	Reservation	Alucard	28/06/2018, 20:25:42	Reservation under the name Brian Johnson was modified.
Add	Reservation	Alucard	28/06/2018, 20:22:01	Reservation under the name Brian Johnson inserted at 1bd apt 103 on 10 July 2018
Add	Reservation	Alucard	28/06/2018, 20:18:33	Reservation under the name Claire Wills inserted at 1bd apt 303 on 29 June 2018
Add	Reservation	Alucard	28/06/2018, 20:07:30	Reservation under the name Tim Owens inserted at 2bd apt 102 on 23 June 2018
Add	Reservation	Alucard	28/06/2018, 20:06:11	Reservation under the name Tim Owens inserted at 2bd apt 102 on 19 June 2018
Add	Reservation	Alucard	28/06/2018, 20:04:42	Reservation under the name Panagiotis Moraitis inserted at 1bd apt 103 on 29 June 2018
Add	Reservation	Alucard	28/06/2018, 19:49:21	Reservation under the name Michael Stevens inserted at 2bd apt 204 on 29 June 2018
Modify	Reservation	Alucard	28/06/2018, 19:46:52	Reservation under the name John Doe was modified.
Modify	Reservation	Alucard	28/06/2018, 19:46:39	Reservation under the name Mark Brown was modified.
Modify	Reservation	Alucard	28/06/2018, 19:45:34	Reservation under the name John Smith was modified.
Modify	Reservation	Alucard	28/06/2018, 19:45:31	Reservation under the name John Smith was modified.
Modify	Reservation	Alucard	28/06/2018, 19:45:22	Reservation under the name John Smith was modified.
Modify	Reservation	Alucard	28/06/2018, 19:45:13	Reservation under the name Jane Anderson was modified.
Modify	Reservation	Alucard	28/06/2018, 19:42:06	Reservation under the name Mark Brown was modified.
Modify	Reservation	Alucard	28/06/2018, 19:42:04	Reservation under the name Mark Brown was modified.
Modify	Reservation	Alucard	28/06/2018, 19:41:50	Reservation under the name John Doe was modified.
Add	Reservation	Alucard	28/06/2018, 19:40:47	Reservation under the name Jane Anderson inserted at 2bd apt 102 on 16 June 2018
Add	Reservation	Alucard	28/06/2018, 19:39:04	Reservation under the name Sam Rogers inserted at Suite 301 on 19 June 2018

Figure 33: Log page

The purpose of the logs page is to provide the end-user with a comprehensive list of actions performed by all users of the property and their exact timeframe. Examples of recorded events include: reservation additions, modifications or cancellations, rate plan or contract changes, modifications to the available rooms etc.

The results are split into several pages. Each page displays 25 records and all records are sorted based on the Date/Time column.

A search function is also available to assist with quick record finding. The end-user can, for example, type in a customer's name or the reference number of a reservation to display only records relating to this specific entry.

This list could be expanded to record more events, such as room status changes by housekeeping staff, reservations made through the hotel's website or connected OTA's and more.

From a developer's standpoint, the tricky part (or more accurately, the more code intensive part) would be to track and display the exact changes made on a record. For example, tracking the exact changes made on a reservation, when editing one. Changes regarding to room occupancy, price, comments added, dates and more.

Settings

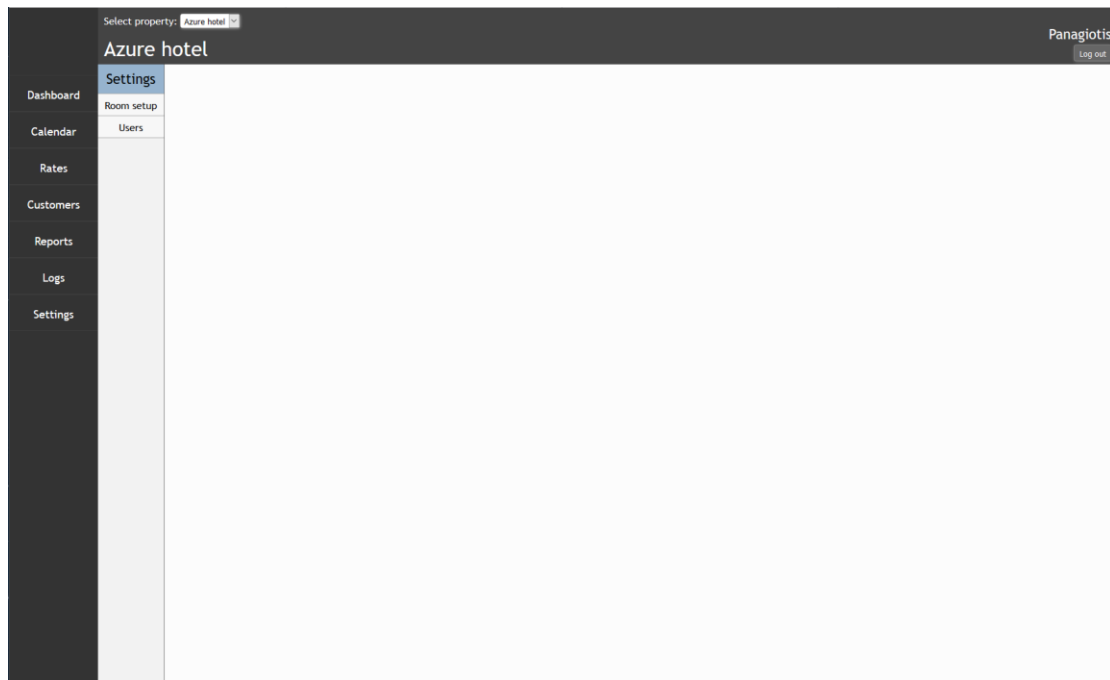


Figure 34: Settings main page

The settings page is where the end-user can access the various settings of the application, using the sub-menu on the left, next to the main navigation.

Room Setup



Figure 35: Room setup

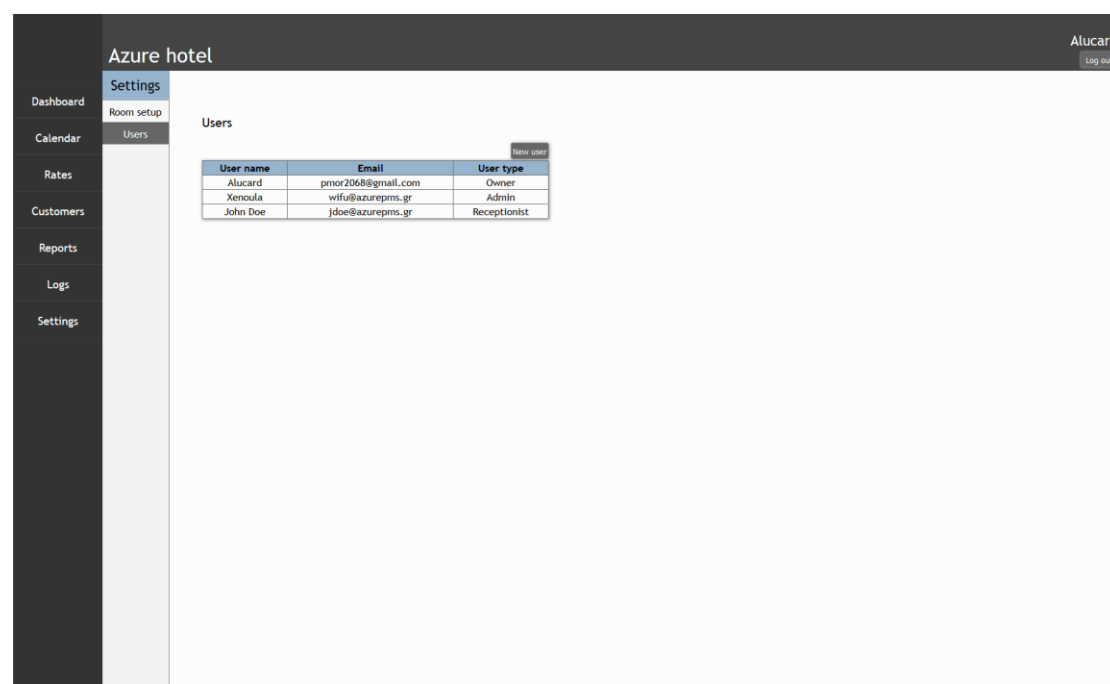
In this page, the user can configure the various room types and rooms available in the property. It is the first thing that the user must set up, in order to have any kind functionality in the rest of the PMS modules.

The user is first asked to specify a room type, along with the default room capacity for this type and then add rooms as necessary. Each room can have a different capacity.

This room list is used by several modules of the PMS, such as the calendar, where each room represents a row, the rates, where the user can provide prices for each room type etc.

More functionality should be added to this page, by allowing re-ordering of room types/rooms via drag & drop support.

Users



The screenshot displays the 'Users' management page within the 'Azure hotel' settings. The page features a dark sidebar on the left with navigation options: Dashboard, Settings (selected), Room setup, Calendar, Users, Rates, Customers, Reports, Logs, and Settings. The main content area is titled 'Users' and contains a table with the following data:

User name	Email	User type
Alucard	pmor2068@gmail.com	Owner
Xenoula	wifu@azurepms.gr	Admin
John Doe	jdoe@azurepms.gr	Receptionist

A 'New user' button is located above the table. The top right corner of the page shows the user 'Alucard' and a 'Log out' button.

Figure 36: Userlist page

In this page of the application's settings, the end-user can specify a new user that can access the PMS and modify or delete existing users from the list, provided that he has the necessary permissions to do so.

There are currently four user types:

- Owner: this is the owner of the property and can add or delete users at will. The owner is not restricted by permissions in any of the PMS modules.
- Admin: this is a user with elevated rights (typically a manager position at the property) and can add, modify or delete users below this rank. Admin users can only be created by the owner.
- Receptionist: Users typically employed at the front desk. This user type does not have the permission to modify the user list and may have limited permissions throughout the PMS modules.
- Housekeeper: This consists of the cleaning staff of the property. This type of user may have limited access to the PMS modules and should only be able to modify the status of a room (clean, in of cleaning, sheet changes, etc.).

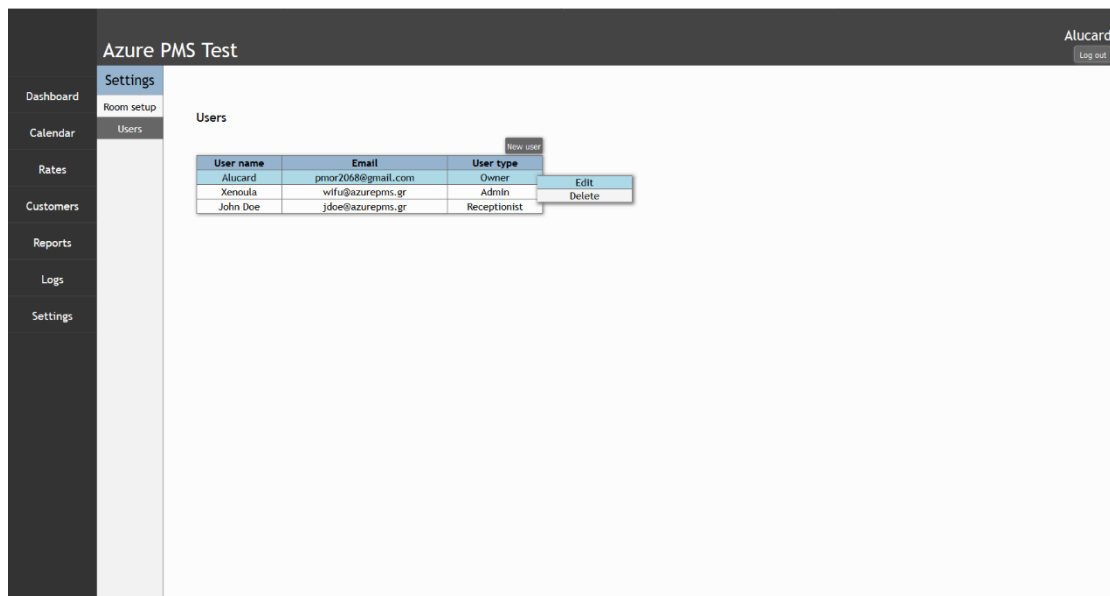


Figure 37: Users list

In the figure above, the main users page is visible. A list of registered PMS users for this property, is displayed on this page.

Right-clicking at an entry, will bring up the context menu and offer a list of actions. Not all actions listed are usable, depending on a user's permissions.

The screenshot shows a web application interface for 'Azure PMS Test'. On the left is a dark sidebar with navigation links: Dashboard, Calendar, Rates, Customers, Reports, Logs, and Settings. The 'Settings' link is active. The main content area is titled 'Edit user' and contains the following form elements:

- Email address: pmor2008@gmail.com
- Username: Alucard
- User type: Owner (with a dropdown arrow)
- A link: [Change password!](#)
- Old Password: [text input]
- New Password: [text input]
- Repeat Password: [text input]
- Submit button

In the top right corner of the application, the name 'Alucard' and a 'Log out' link are visible.

Figure 38: User form

In figure 38, the user registration form is visible. The user must specify an email address, username, user type and a password to register a new user.

When editing an existing user, the username and user type can be modified (except for owners). A user is also able to change his/her own password.

PMS feature synopsis

So what can this PMS solution offer to a hotel at this point?

For starters, it can be used to effectively and efficiently manage the reservations of a property in its modern and user-friendly calendar, from any desktop or mobile device.

Its cloud-based model, ensures that changes made on one terminal are automatically pushed to every connected user, on every device.

It can be used to manage the different rate plans and record all the various contracts that a hotel might have, providing automatic pricing to reservations entered in the calendar module.

It allows the hotel to maintain detailed guest information, in the customer database, where new guest entries are automatically created when a reservation is made. This list can also be edited manually. When making a new reservation, existing customers from this list can be selected, to occupy the rooms.

The dashboard page can be used to provide a quick overview of the latest arrivals, departures, user actions and statistics.

Detailed statistics regarding the hotel's operations can be obtained using the reports module, such as occupancy, revenue and reservation source. These reports are displayed as modern charts on the PMS and can be exported as images or raw data.

An actions log, with a powerful search function is available, to help the hotel keep track of changes made in reservations, the customer database, rate plans etc. and all of the PMS modules.

Lastly, the PMS can be configured to provide access to as many different users as needed by a hotel, simultaneously and can also be used to manage many different properties from a single account.

What is missing from this PMS?

Given the limited timeframe of this thesis and its scope, there are, of course, missing features, that a competitive PMS on the market should offer.

These include features like, housekeeping – maintenance management, payments management, invoicing support, online bookings and OTA/GDS integration – connectivity.

Conclusion

In conclusion, a strong basis for a PMS with a clean code base was developed, along with comprehensive core features, such as powerful reservations & guest management, detailed reports, logging, powerful user management etc. which can be expanded upon, beyond this thesis, to include features common in PMS solutions found in the market.

Epilogue

As I mentioned at the beginning of chapter 2, I began this project as a beginner in the field of web development.

They say that the best way to learn programming in a new language or field, and to gain expertise in it, after reading up on the fundamentals and following some basic tutorials, is to start working on a personal project. Only by designing, coding, doing research on how to implement new things and trying to solve the issues that arise from these, you can truly understand what's going on.

Coming from a different educational field, my previous degree being in mechanical engineering, but always versed in computers and having an interest and some previous experience in programming, this project was the perfect opportunity for me to get in the world of web development and it served this purpose extremely well.

This project, in all, is comprised of seven main modules and several other sub-modules that derive from the main ones or provide configuration to them. It took around eight months of development (part-time for the most part) to reach this level of functionality, deemed sufficient for the purpose of this thesis.

I have an interest, beyond the scope of this thesis, to continue development on this PMS and offer it as a product in the future. I have plenty of ideas on where to go next, what features to develop and how to evolve the existing ones.

To go from the state of the application at the time of the completion of this thesis, to this being a finished product, ready to take on the market, I believe it will require at least another year to a year and a half of development.

On a personal level, I'm looking forward to tackling the challenges that lie ahead in making this application what I envisioned it to be and learning a lot more about the inner workings of the worldwide web in the process.

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