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Property Management Analytics (OLAP) System

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Abstract

In information technology, on-line analytical processing (OLAP) is an approach or technique to analyze the raw data in multi-dimensional analytical perspectives to provide summaries. OLAP consists of basic analytical operations such as consolidation (roll-up), drill-down, and slicing and dicing. This involves aggregation of data that can be accumulated and computed in one or more dimensions based on the data hierarchy. Typical applications of OLAP include "key performance indicators" i.e., does the current value satisfy the goal, business reporting for sales, marketing, management reporting, business process management (BPM), budgeting & forecasting, financial reporting. OLAP functionality depicts the multi-dimensional analysis of consolidated enterprise data supporting end user analytical and navigational activities including: calculations and modeling applied across dimensions, hierarchies, trend analysis over sequential time periods, and drill-down to deeper levels of consolidation.

OLAP encompasses:

- Relational database

- Report writing

- Data mining

Databases configured for OLAP uses a multi-dimensional data model, allowing for complex analytical and ad-hoc queries with a rapid execution time. They borrow aspects of navigational databases, hierarchical databases, and relational databases that allow business users to slice and dice data at will. Property Management Analytics (OLAP)

System is being developed for the in-house use for meeting business needs from time to time. This Property Management Analytics (OLAP) System will extensively be used by managers and service providers, which will help in making certain business decisions. It was developed for this audience to be able to provide better service. A key feature of this Property Management Analytics (OLAP) System is embedding business portability centralized to one system.

Introduction

A successful company has many decisions to make. The better those decisions are made, the more successful, and profitable, the company is likely to be. To many chief decision makers the ability to analyze faster and better than the competition means better decisions, higher profitability, and more success. In business intelligence, on-line analytical processing is a computer-based process of analyzing raw data which enables business analysts, managers, and executives to gain insight into data or information through fast, consistent, and interactively services where the fine-grained information is transformed from large volume of raw data to reflect the real dimensionality for business needs. OLAP systems help us to synthesize enterprise information through comparative, personalized viewing, as well as through analysis of historical and projected data in various "what-if" data model scenarios enabling decision makers to make appropriate decisions on time achieving business goals. On-line Analytical Processing (OLAP) allows users to perform quick and effective analysis on large volume of data. The data are stored in a multi-dimensional fashion that more closely models real business data. OLAP also allows users to access summary data faster and easier. They can then drill down into

the summary figures to get more detailed data, if needed. The main objective of this Property Management Analytics (OLAP) System is to consolidate the income earned from different rental and managed properties and provide an efficient and effective way of managing the rental and managed properties. Managed properties are the properties that are under contract for maintenance as outlined with service level agreements for a defined period of time as offered by the property management analytics from time to time. The services for different managed property may vary based on the package and service being selected during contract. This model will provide a complete view of how each property is performing so far as the income is concerned. In addition, this Property Management Analytics (OLAP) System also provides the user a suitable GUI for ingesting the property, tenant, and billing details into the relational database. This system not only helps as an analytical decision support system but is also capable in managing the property, tenants, and billing data in a way that analysts can preserve or store their day to day business. The Property Management Analytics (OLAP) System identifies the gaps and provides users a "savings catcher" option in the process of business selection needed to maximize user's savings and gain business from time to time. This savings catcher helps for managed properties in the process of selecting the business package with its associated services so as to maximize the saving. Managers need this Property Management Analytics (OLAP) System to take quick business decisions on the fly with flexible decision support system, as making a wrong decision or taking too long to make a decision can affect the competitive position of the organization. The system provides the business earned in different drill down reports for easy reference purposes. Thus, the collaboration of preserving rental and managed details to the database and analytical

service of the Property Management Analytics (OLAP) System could effectively be used to sustain the growth, maximize the business, and minimize losses in rental environments. The goal of Property Management Analytics (OLAP) System is to be used by managers and service providers in supporting certain business decisions. The aim is to clearly depict the multi-dimensional analysis of consolidated enterprise data towards supporting end user analytical and navigational activities.

Background and Related Work

There exist different types of OLAP Technologies in the market such as cube-based Multi-dimensional OLAP–(MOLAP), Relational Star Schema-based OLAP-(ROLAP), and Hybrid OLAP-(HOLAP) that includes features of both ROLAP and MOLAP System. At the same time, there exist different OLAP products in the market such as ModelKit™, Microsoft Analysis Services (SQL Server), IBM's DB2 Cube Views, SAP BW, Information Builders' Web FOCUS, TM1, Essbase, Mondrian and products from SAS Institute, Brio, Business Objects, Cognos, and MicroStrategy. Moreover there exist many open sources tools as well for OLAP offerings, e.g., for ROLAP reporting there is the java-based Mondrian and Palo for MOLAP analysis. Regardless of the different types, all OLAP architectures involve building a multi-dimensional data structure, where dimensions represent different business entities. The major issues regarding the multi-dimensional data structure include the following:

- When and how is the multi-dimensional data structure constructed?

- Where does the multi-dimensional data structure live and how persistent is it?

Some OLAP technologies require an extract, transform, and load (ETL) process, which typically runs at off-peak hours to build and update a persistent multi-dimensional data structure. It is vital and necessary that to sustain the business one should be able to perform analysis on the fly, which will be more accurate if OLAP accesses data sources directly and build/perform the analytics.

Program Requirements

Property Management Analytics (OLAP) System is a tool proposed for managing, and supporting the business needs of small firms. Property Management Analytics (OLAP) System is a Hybrid OLAP System that allows the management and storage of source data in a relational data store. This system allows user to log on to the system and perform operations as needed to manage their day to day activities. The Property Management Analytics (OLAP) System is able to store and maintain property details for rental property or manage property, tenant details, and respective payment or billing details. As an elegant analytics system, the Property Management Analytics (OLAP) System is also able to provide the customer an option to maximize "savings" where customers could select their tenure of lease for properties and maximize savings while selecting the type of package available with associated service types, hence it is named "Savings Catcher Analytics". The Property Management Analytics (OLAP) System provides a service for "Cost Benefit Analysis" by tracking and analyzing existing customer points. Tenant cost points is an approach where point's calculation is based on tenants or leased property that has caused any cost to the firm in any way along with their tenure of occupancy vs cost being incurred. Tenants having more than two cost points and managed property having more than four points are not allowed to renew their next lease. The cost points are

evaluated and based on the cost point level he/she will not be allowed lease renewal or renting new premises directly without supervisor or manager's decision. This is implemented as a measure to minimize the cost in property management. The Property Management Analytics (OLAP) System is capable of producing the total rental income by Properties and by Fiscal Year. It provides the option to drill down to the lowest level of data granularity and data cardinality. It is able to provide "trend analysis", i.e., what is the value over time? Managers may use slicing or dicing the data to see the market trend and take corrective action to augment business growth. Users of this Property Management Analytics (OLAP) System should be able to perform ad-hoc queries based on business need. They should be able see which tenant has pending payments and which tenants have multiple numbers of payments for the same month. They may sort, search or query to meet different day-to-day business requirements. This system has the flexibility of producing different analytics such as cost benefit analytics; actual vs forecast analytics, analytics on unit's (i.e., occupied vs vacant), comparative, and percentile and monthly trend analytics. The users and managers of this system are able to manage the system in an efficient way to optimize the use of resources and augment the earnings.

Implementation

Below are the lists of technologies and tools being used in the process of developing Property Management Analytics (OLAP) System.

❖ **RAD Version 8.0.4:** Rational Application Developer for WebSphere provided by IBM®, an Eclipse based (IDE) integrated development environment that accelerates the development and deployment of Java, Web 2.0, mobile, OSGi, portal and service-

oriented architecture (SOA) applications. The Integrated Features of RAD makes it easier for analysis, development and testing which increases productivity, efficiency in delivering the application.

This tool accelerates development and maintenance of web and mobile applications and speeds the development of services and Java applications with productivity tools supporting the latest Java EE and SOA programming models. It is optimized for IBM middleware, including the new, lightweight Liberty Profile, the full WebSphere Application Server profile, the IBM WebSphere Portal Server. It also provides flexible deployment options and rich integrations with Rational Collaborative Application Lifecycle Management solution to help raise productivity and improve quality outcomes.

❖ **Relational Database**: Oracle as the object-relational database management system is used to preserve and maintain property, tenant, and billing information in different table objects in a star schema model. Advanced structured query (SQL) and procedural language (PL/SQL) is used for populating the dimensions and fact table objects. Different business functional logic is embedded in extract, transform, and load (ETL) process for populating different aggregated table objects from dimensional table entities based on the data cardinality. Views are created on the top of aggregated tables for different analytics for faster and better performance. ORALCE 11g is selected because of its high scalability and enrich analytical functionality. Analytical functions including lead, lag, and partitioning have potential use in this system.

❖ **SQL Developer:** Oracle SQL Developer is used in writing and testing the functionally of the query and other objects. SQL Plus and Oracle SQL Developer were used in query writing and objects like trigger, procedure, function, and package testing.

❖ **jQuery:** jQuery is a lightweight "write less, do more" javascript library that makes writing java scripts and jQuery simple. UI provides everything needed for building a web page. jQuery performs common tasks that require many lines of javascript code to accomplish and wraps them into methods that can be called with a single line of code. The vast jQuery library and plugins contain several features like HTML/DOM manipulation, CSS manipulation, HTML event methods, effects, and animations.

❖ **Javascript:** Javascript is a computer programming language and is used as a part of web browsers whose implementation allows the scripting in the client side to interact with the user. It gives control of browsing and altering the document content to the user. It can also be used for server side programming. Property Management Analytics (OLAP) System uses javascript for creating the objects and java servlet to navigate from one selection to another for property, tenant, and billing management process. Validations at each level in different forms extensively use javascript.

❖ **Ajax:** Ajax is an acronym for asynchronous javascript which is useful for asynchronous applications such as Property Management Analytics (OLAP) System. It has to communicate to the DBMS back and forth in different phases of the process to send and retrieve data from the server asynchronously without interfering with the display and content of the current page. Property Management Analytics (OLAP) System uses Ajax for table-data search and sorting capability. Processes such as

savings catcher, cost point analytics, manage billing options, billing search, pagination, and sorting use this tool.

❖ **HTML & CSS:** CSS is used to manage and align the web pages with different styles available in CSS. The main menu is designed with a different style sheet of the CSS plugins with enriched HTML and javascripts. CSS is a cornerstone technology used by most websites to create visually engaging webpages, user interfaces for web applications, and user interfaces for many mobile applications.

Depicted below (in Figure 1) is the data flow diagram of Property Management Analytics (OLAP) System.
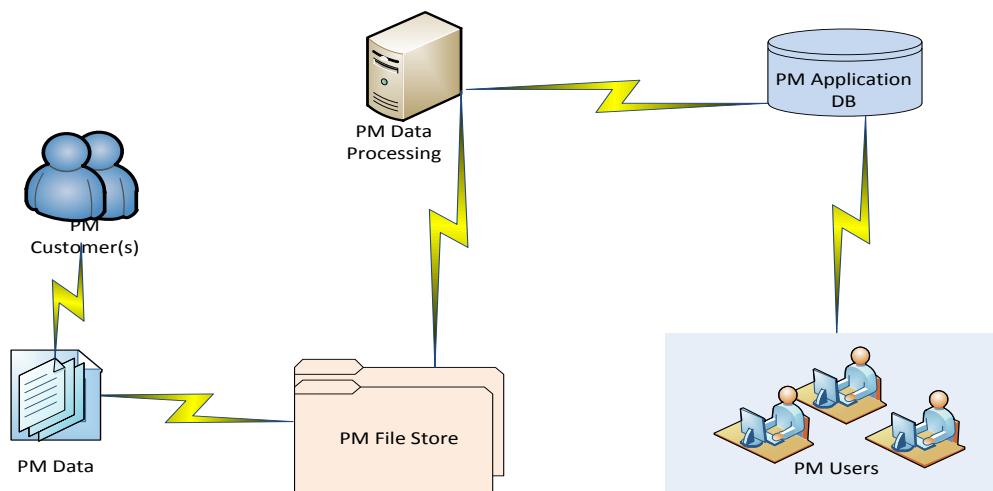
Figure 1: Technical Specification of the Property Management Analytics (OLAP) System

Depicted below (in figure 2) is the logical architecture of Property Management Analytics (OLAP) System where the client sends HTTPS requests and receives the response back from the system. The presentation layer works with the business logic layer which in turn communicates with the database server interactively. Users of this system could also use stand-alone Oracle SQL Developer or SQL Plus to connect to the relational database for querying purposes.
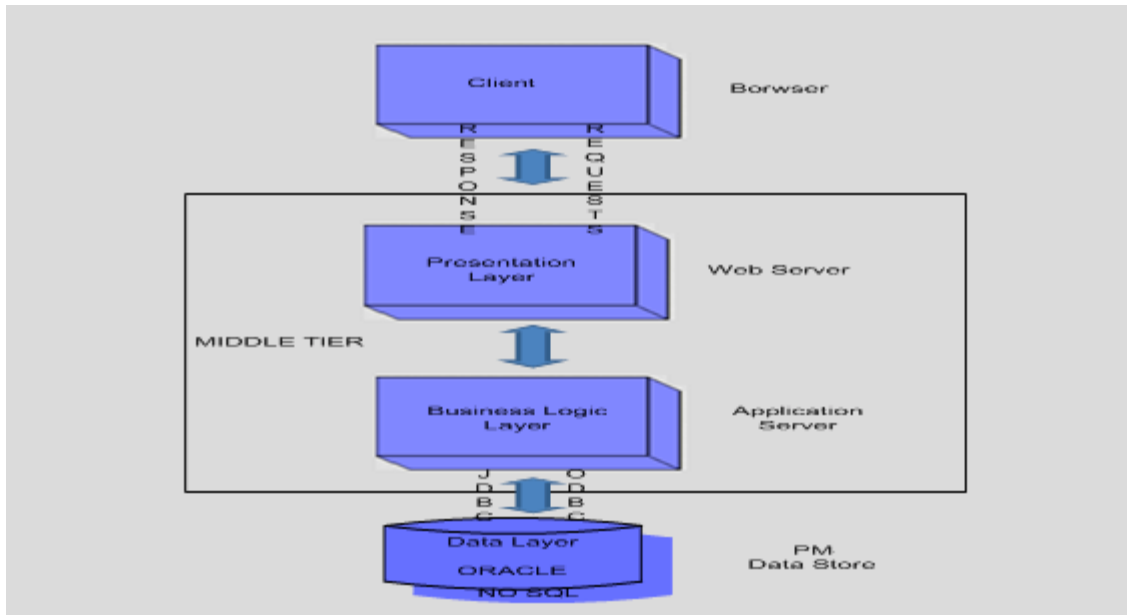
Figure 2: Architectural Diagram of the Property Management Analytics (OLAP) System

Results, Evaluation, and Reflection

The savings catcher algorithm supports the new or existing customers in selecting their lease tenure and maximize saving. At the same time it preserves the property, tenants, and billing information. Users maintain their inventory of units updated with vacate notices as needed. Users pull different reports from the available menu options. The dashboard reflects the changes and pulls data from database directly. Google Map Analytics also provides geospatial details.

The Property Management Analytics (OLAP) System is efficient enough to perform under low to medium volume of data as shown below in figure 3. The volume matrix analysis was tested with total of 2 managed and 2 rental properties having 147 occupied units out of 162 total available units for 3 years of billings. The regression test shows that performance is satisfactory for retrieving OLAP results after several milliseconds.

PROPERT NAME	PROPERTY TYPE	PROPERTY STATUS	NO OF UNITS	NO OF TENANTS	1 YEAR BILLs	2 YEAR BILLs	3 YEAR BILLs
Crystal Waters	Manage	OCCUPIED	1	1	12	24	36
Savannah Lake	Manage	OCCUPIED	1	1	12	24	36
Crown Point	Rental	PRE_OCCUPIED	50	50	600	1200	1800
Crown Point	Rental	OCCUPIED	40	40	480	960	1440
Crown Point	Rental	VACANT	10	10	0	0	0
Meadow Springs	Rental	OCCUPIED	55	55	660	1320	1980
Meadow Springs	Rental	VACANT	5	5	0	0	0
Total: (Billing Records)			162	147	1764	3528	5292
Access Timing in Milliseconds					2	3	3

Figure 3: Volume Matrix Analysis for Property Management Analytics (OLAP) System

The above volume matrix analysis testing utilized no partitioning mechanism or indexes.

Figure 4 depicts the performance evaluation analysis over four properties over 34,000 tenants having 1,224,000 billing records were able to process under satisfactory timing as outlined in the table below.

PROPERT NAME	PROPERTY TYPE	PROPERTY STATUS	NO OF UNITS	NO OF TENANTS	1 YEAR BILLs	2 YEAR BILLs	3 YEAR BILLs
Crown Point	Rental	PRE_OCCUPIED	9000	9000	108000	216000	324000
Crown Point	Rental	OCCUPIED	8000	8000	96000	192000	288000
Meadow Springs	Rental	PRE_OCCUPIED	9000	9000	108000	216000	324000
Meadow Springs	Rental	OCCUPIED	8000	8000	96000	192000	288000
Total: (Billing Records)			34,000	34,000	408,000	816,000	1,224,000
Process	Refresh Timing in Seconds					116	173	186
Access Timing in Milliseconds					3	3	4

Figure 4: Performance Evaluation Analysis for Property Management Analytics (OLAP) System

The above performance evaluation analysis with four properties over 34,000 tenants having 1,224,000 billing records were able to process under satisfactory timing as outlined above in figure 4. To produce an upper bound result tables have referential integrity constraints as well as input data validation via Ajax with the graphical user interface and javascripts.
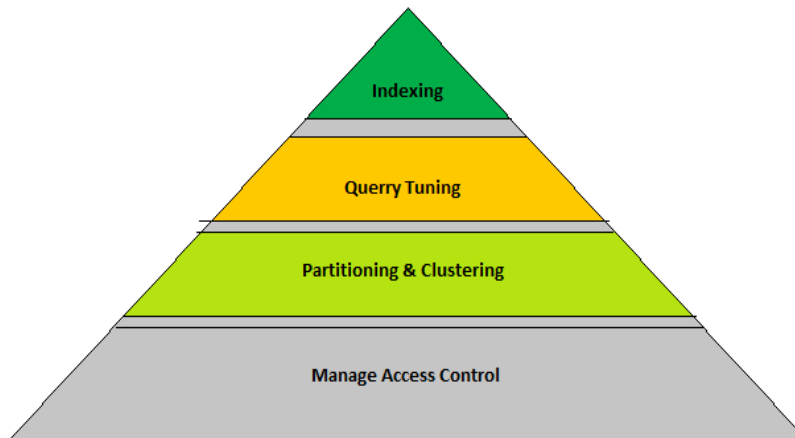
Figure 5: Key Factors to consider in the Property Management Analytics (OLAP) System

The system is capable enough to meet the customer expectations as outlined with the initial release.

Conclusions and Future Work

Batch processing has not been implemented in this release which could be extended in the future. Taking expenses into account to derive a better picture and build analytics on top of the expenses module would give additional functionality to this Property Management Analytics (OLAP) System. Some of the validations in input fields such as social security number and address could be considered in the next release. In Property Management Analytics (OLAP) System the raw data needs to be fine-grained to build the analytics from the dimensions and aggregated tables and build reports out of them. A mechanism of running the inbuilt process in off hours in a scheduled manner is a necessity to decrease business hour impact. A tool such as CA Autosys, IBM TWS, Oracle DBMS Scheduler, or cron job is needed for scheduling. Not all possible DB precautions have been embedded in the UI and are done at back end.

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Appendices

Depicted below (in figure 5) is the data model for Property Management Analytics (OLAP) System.
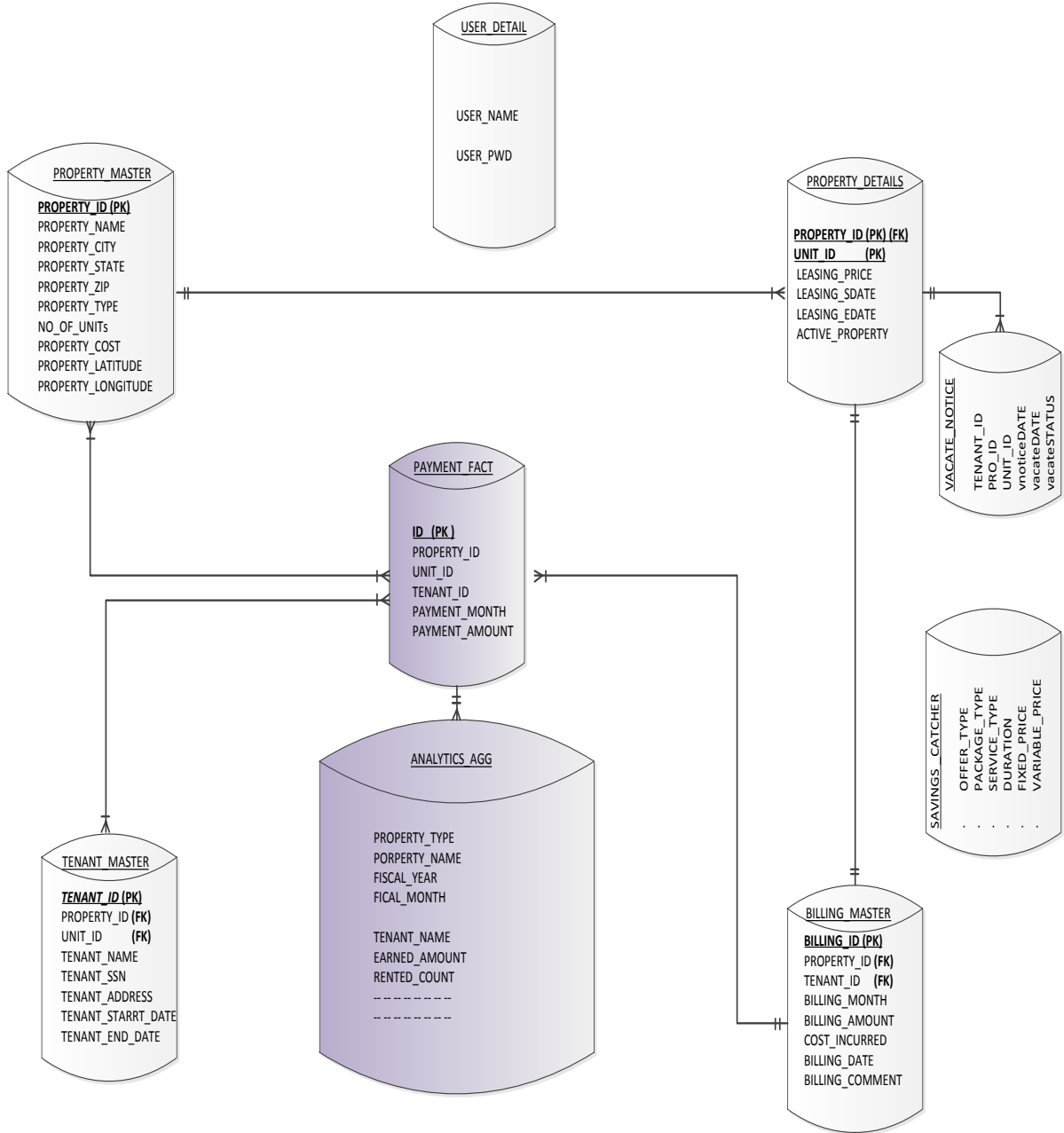
Figure 6: Data model Diagram for Property Management Analytics (OLAP) System

URL: http://localhost:9080/Gvsu/login.jsp

Figure 7: User log-in page of the Property Management Analytics (OLAP) System

After a successful log on, the following menu or screen is available as below to work with the Real Property Management OLAP System:

Home:
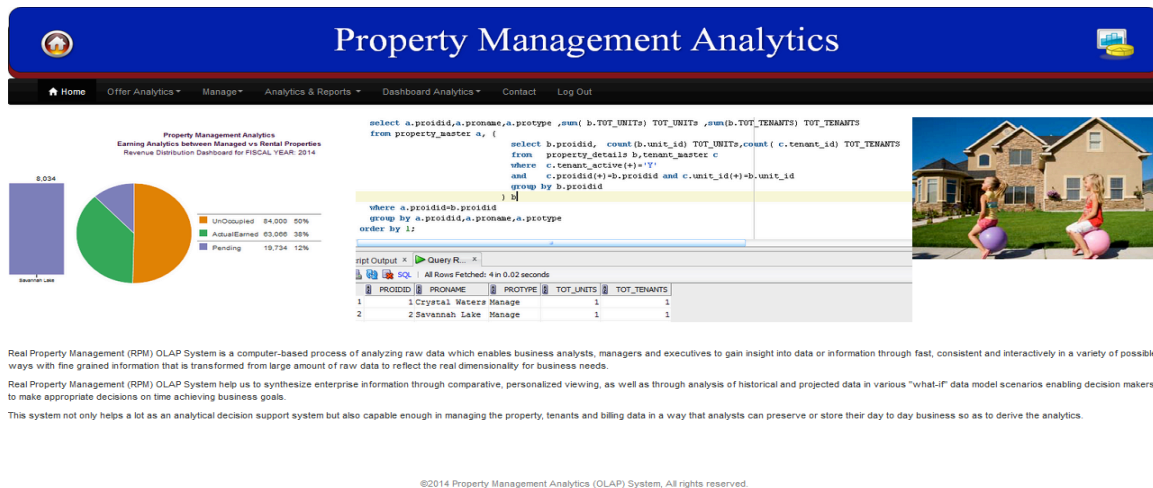
Figure 8: Home page of the Property Management Analytics (OLAP) System

Below is the list of available Menu Items corresponding to their functionality as explained.

Offer Analytics: Select the Saving(s) Catcher option from offer Analytics Menu to work.
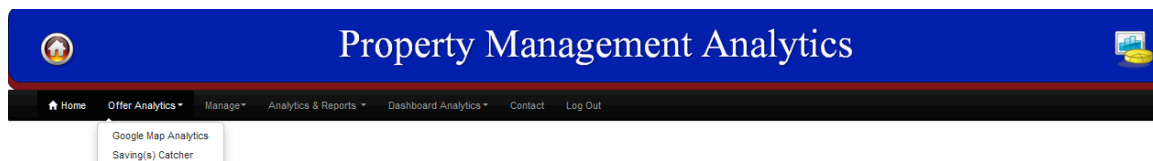
Figure 9: Offer Analytics Menu Details, of the Property Management Analytics (OLAP) System

Google Map Analytics: This feature of Property Management Analytics (OLAP) System displays the location of property with a markup and on clicking the markup it displays the summary details of that property and also if any picture available under that property. If not picture is available will display the summary details.
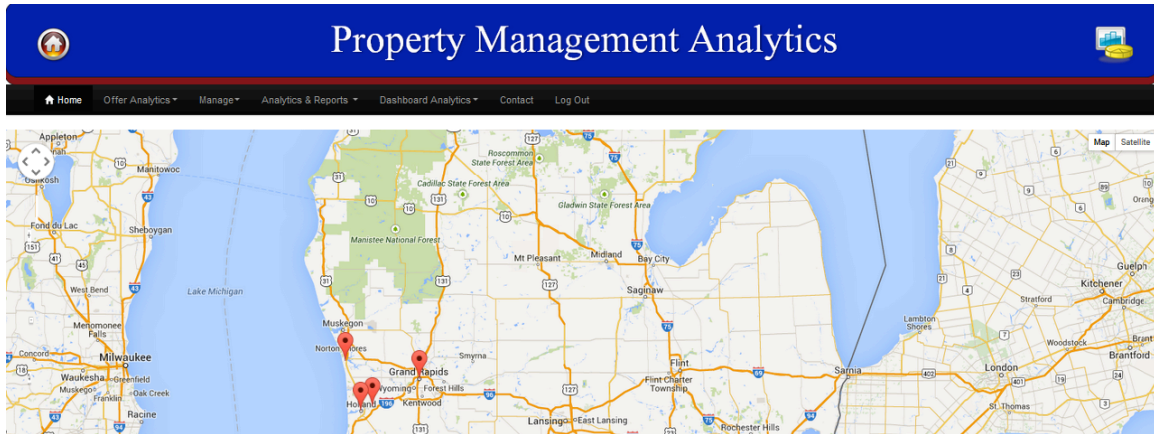
Figure 10: Offer Analytics: Google Map Analytics, of the Property Management Analytics (OLAP) System

Upon clicking on the property marker it will display the specified property details along with picture of the property if available.
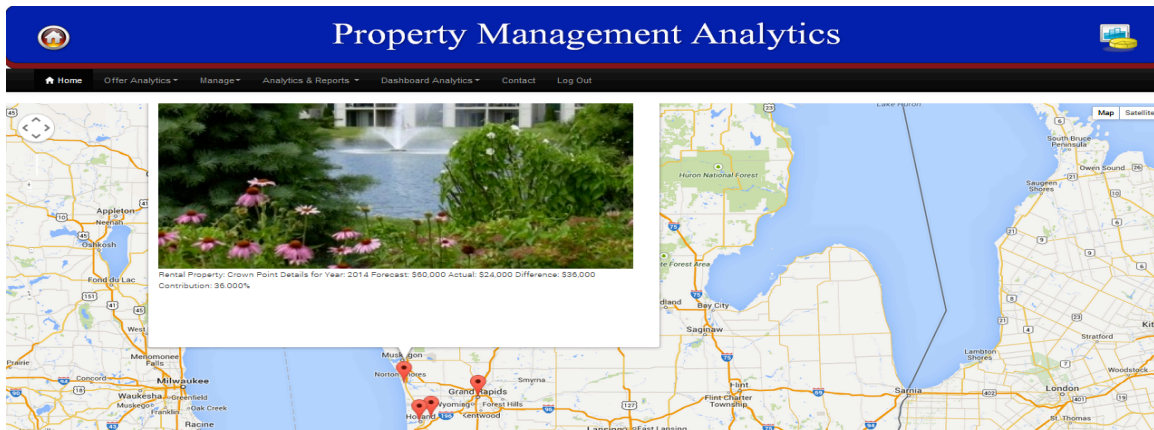
Figure 11: Offer Analytics: Google Map Analytics KPI (Key Performance Indicator)

Saving Catcher Analytics: This Saving Catcher Analytics helps managers to offer and customer of this system to select different packages (Bronze, Silver, Gold) and compare prices with the different services (Basic, Preferred, Premium and Premium Plus) to reach at a suitable package selection and pricing details with added saving she/he can have in selection of the product. There are business requirements that have been embedded inside this approach such that customers must have any given package for a service along with either basic or preferred at minimum service level agreements. However they can compare the price of basic or preferred service level agreements with others e.g.,

premium and premium plus, so as to maximize the benefits along with better service level agreements. Here user can slide through the duration and see the pricing factor and maximize the benefits by seeking a breakeven point. Below is the picture of the saving(s) catcher functionality.
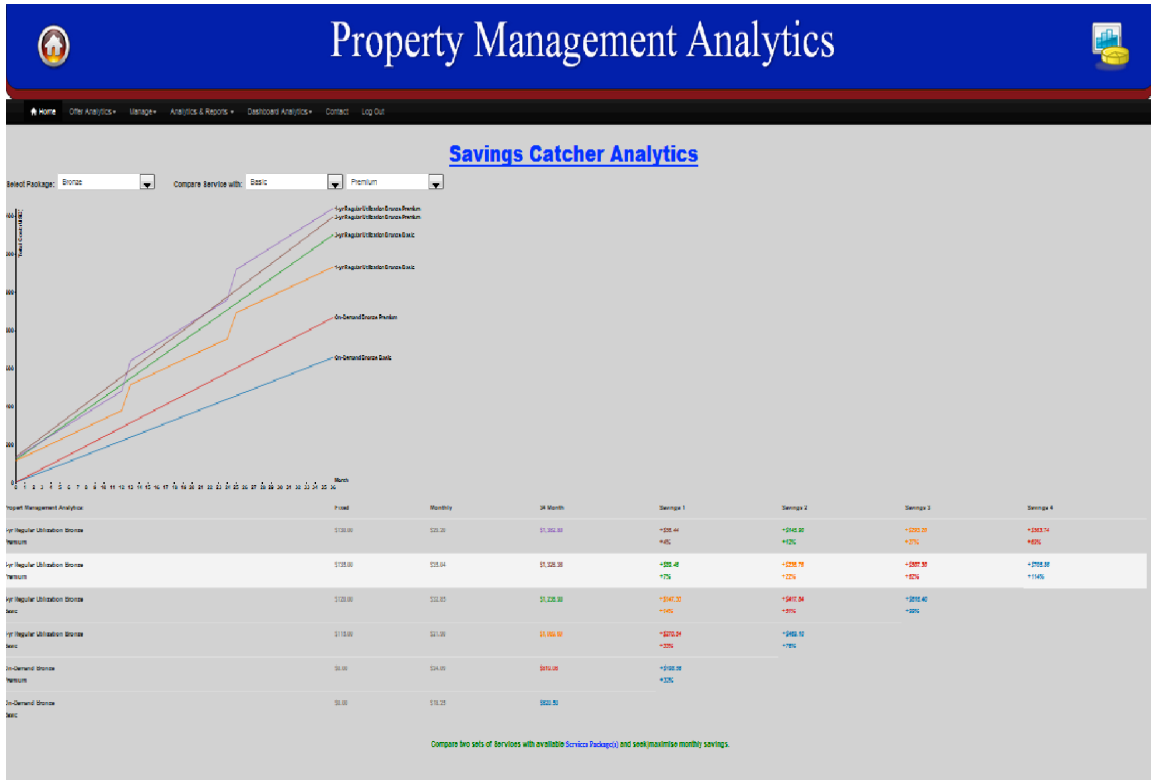
Figure 12: Offer Analytics: Savings Catcher Analytics, of Property Management Analytics (OLAP) System

Manage: Upon Clicking on manage option the system would provide the following options to work with.

Figure 13: Manage: Menu Items, of the Property Management Analytics (OLAP) System

Property: Selecting this option would enable the user to add, modify, delete the property and can view the property details by search property option as show below with highlighted in yellow.

Figure 14: Manage: Property Page of the Property Management Analytics (OLAP) System

Users can delete a property by clicking on the delete. Screen shot of adding and modifying the property by selecting new property or clicking on update as shown below.

Figure 15: Manage: Property Add page

Figure 16: Manage: Property Modify page

When a user selects a property from the available property lists, the system would display the property details along with property status as shown below

Figure 17: Manage: Search by Property page of Property Management Analytics (OLAP) System

Tenant: Selecting this tenant option would enable the user to add, modify, and delete the tenant details along with adding a vacate notice for the tenants and can view the tenant details with tenant status, whether it is an active or inactive tenant. The system also provides options for browsing tenants by property as show.

Figure 18: Manage: Tenants page of Property Management Analytics (OLAP) System

User can delete a tenant by clicking on delete. They can add by clicking on new tenant or can add a vacate notice by clicking on the vacate notice. The screenshots are shown below. The system would also display the tenant details along with status as shown by property.

Figure 19: Manage: Tenants Add page of Property Management Analytics (OLAP) System

From the tenants manage page, a business analyst could modify any given tenants by selecting that tenant and updating the tenant's page as shown below.

Figure 20: Manage: Tenants Update page of Property Management Analytics (OLAP) System

Figure 21: Manage: Tenants Lease Termination page of Property Management Analytics (OLAP) System

Tenant Cost Points: Tenants having more than 2 cost points and managed property having more than 4 points are not allowed to renew their next lease as shown below.

Figure 22: Manage: Tenants Add; Tenants Cost Effective Analytics page

Billing: Selecting this option would enable the user to browse, sort, and query from the search engine in addition to add, modify, and delete a tenant bill as shown.

Figure 23: Billing: Manage Billing page of Property Management Analytics (OLAP) System

Figure 24: Billing: Billing Add page of Property Management Analytics (OLAP) System

Figure 25: Billing: Billing Update page of Property Management Analytics (OLAP) System

Similarly the user could also modify the bill by clicking on the edit icon, delete the bill by clicking on delete icon, and add new bills by add icon.

Analytics & Reports:
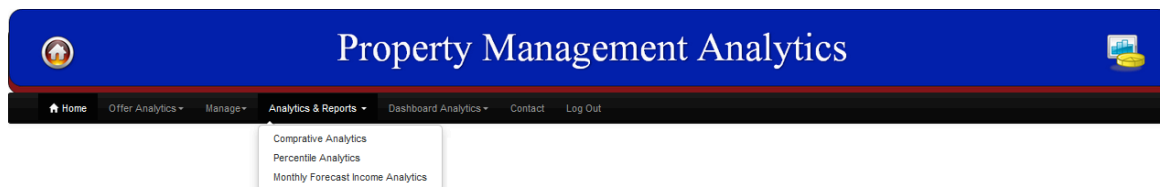
Figure 26: Analytics & Reports: Menu page of Property Management Analytics (OLAP) System

Comparative Analytics: Managers could use this comparative analytics which displays all the measures in a bar graph to compare with different properties so as to take corrective and measurable action as needed. Measures presented in the bar graph are

- Total Units Occupied vs Total Units Vacant
- Total Forecast Revenue vs Occupied Revenue
- Revenue Earned vs Difference in Revenue

Figure 27: Analytics & Reports: Comparative Analytics; Property Management Analytics (OLAP) System

Percentile Analytics: Managers could use this percentile analytics which display percentage of contribution of properties to the total revenue earned as a whole, thus allowing the managers to take effective measures to utilize and maximize the revenue.

Figure 28: Analytics & Reports: Percentile Analytics of Property Management Analytics (OLAP) System

Monthly Forecast Income Analytics: This option provides the monthly forecasted revenue from the different properties so as to plan on the budgeting and other action items. On mouse over to the property it displays the individual percentile contribution as shown in above figure 26 from which user can determine the performance of the property.
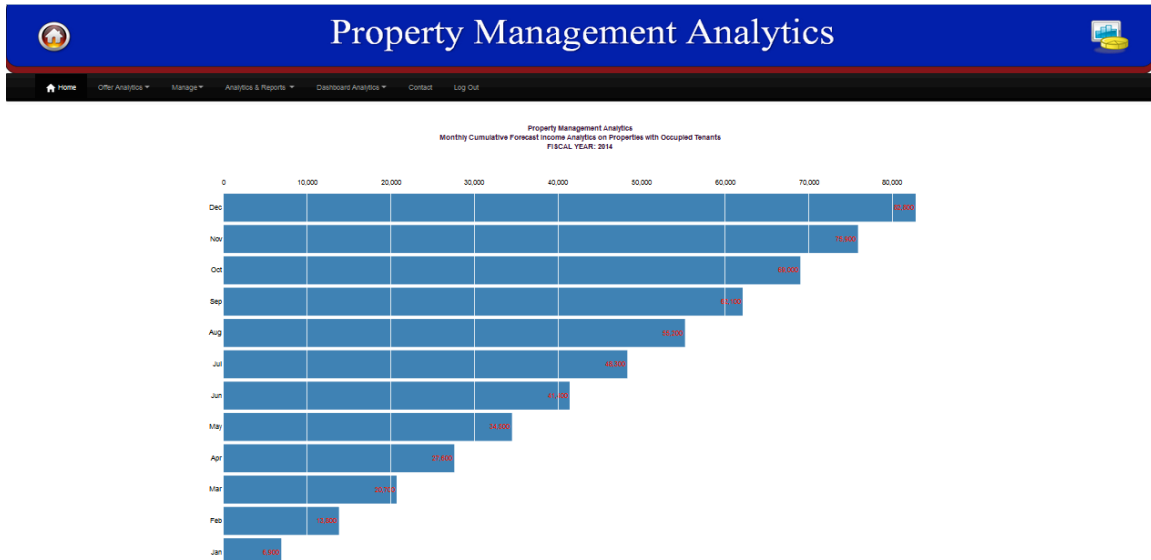
Figure 29: Cumulative Monthly Forecast Analytics; Property Management Analytics (OLAP) System
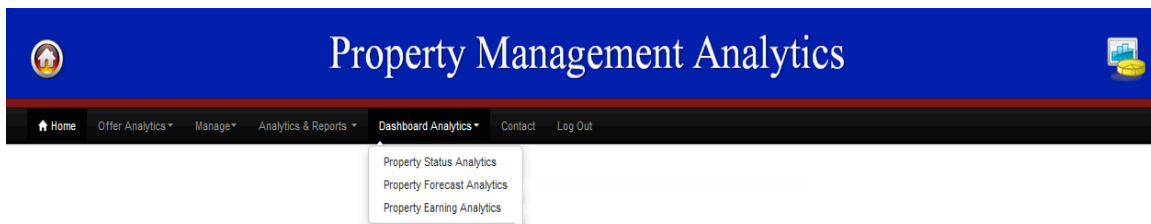
Figure 30: Dashboard Analytics: Menu Details of Property Management Analytics (OLAP) System

 Property Status Analytics: By selecting this option, users of Property Management Analytics (OLAP) System could see the total number of the units available by property along with the percentile of units occupied. Users could also see measure details like units occupied vs vacant by mouse over of the desired property and the value on right will change as appropriate.
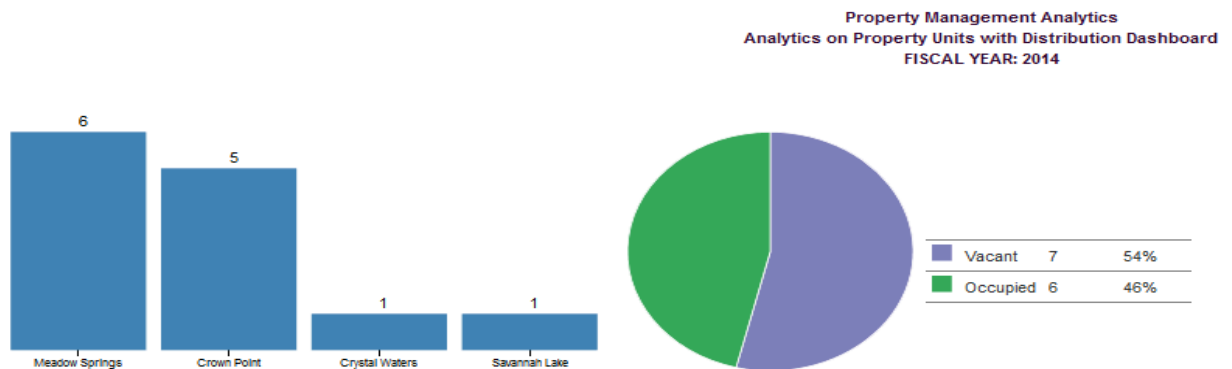
Figure 31: Dashboard Analytics: Property Status Analytics entry of this Dashboard
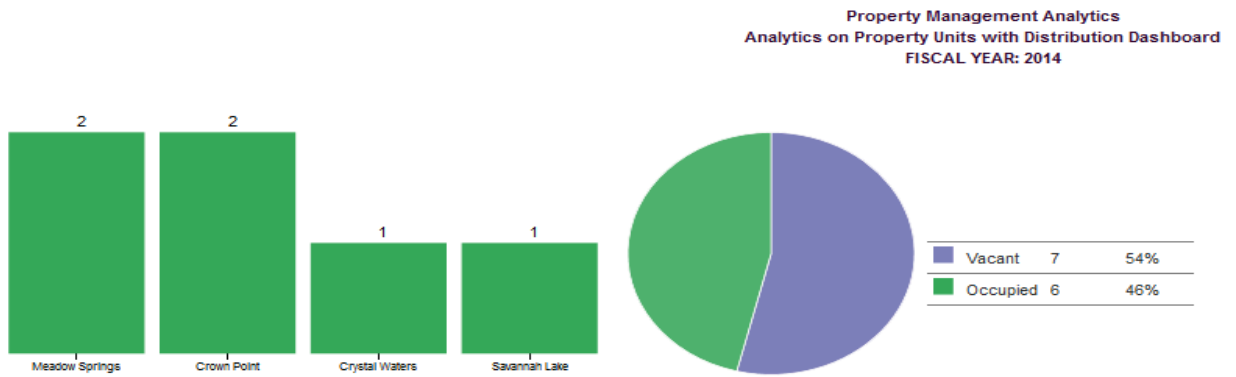
Figure 32: Dashboard Analytics: Property Status Analytics on mouse over to Occupied
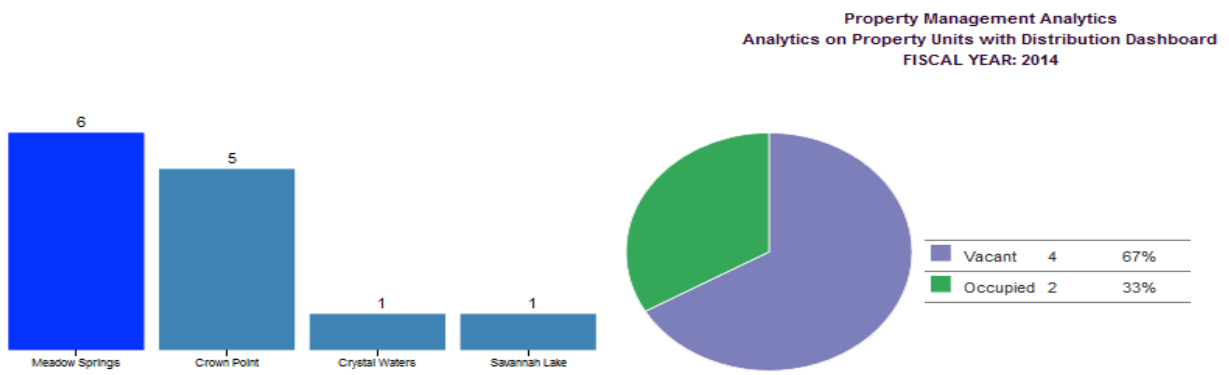
Figure 33: Dashboard Analytics: Property Status Analytics on mouse over to Property Meadow Spring

Property Forecast Analytics: By selecting this, users of this system could visualize the yearly forecast income, forecast of actual revenue to be earned vs difference (loss of revenue due units not being on lease). Users of this system could select a property to see the measures for that property and take appropriate disciplinary business decisions or actions as needed. Mouse over to the appropriate property to visualize the different measures such as actual forecast for the year vs difference of revenue of that corresponding property.
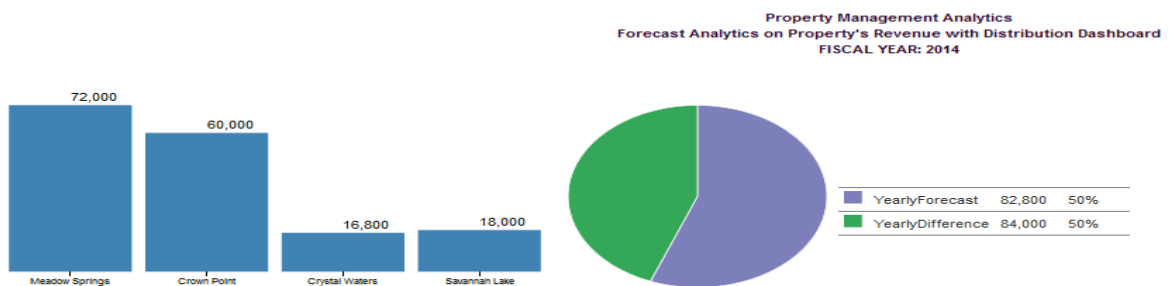
Figure 34: Property Forecast Analytics Home page on selection of this Dashboard
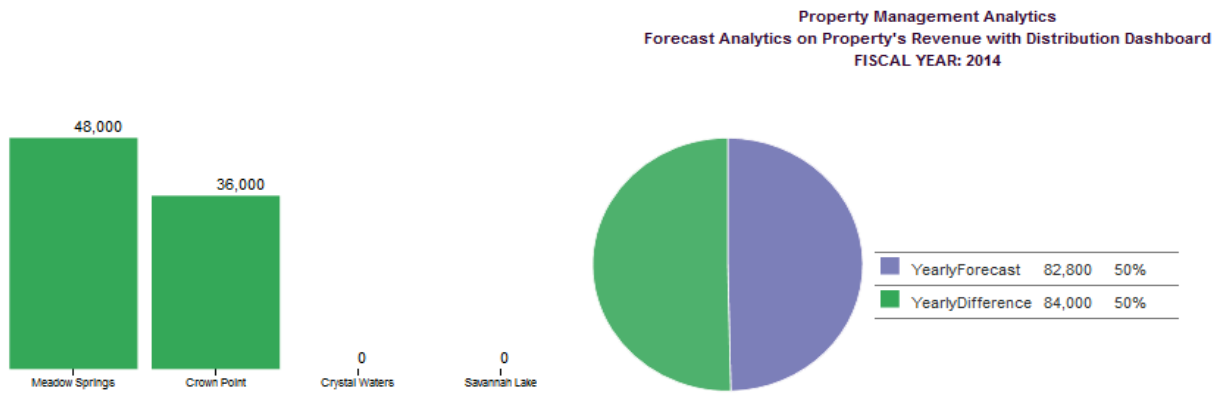
Figure35: Property Forecast Analytics, Mouse over to yearly Difference on the Dashboard
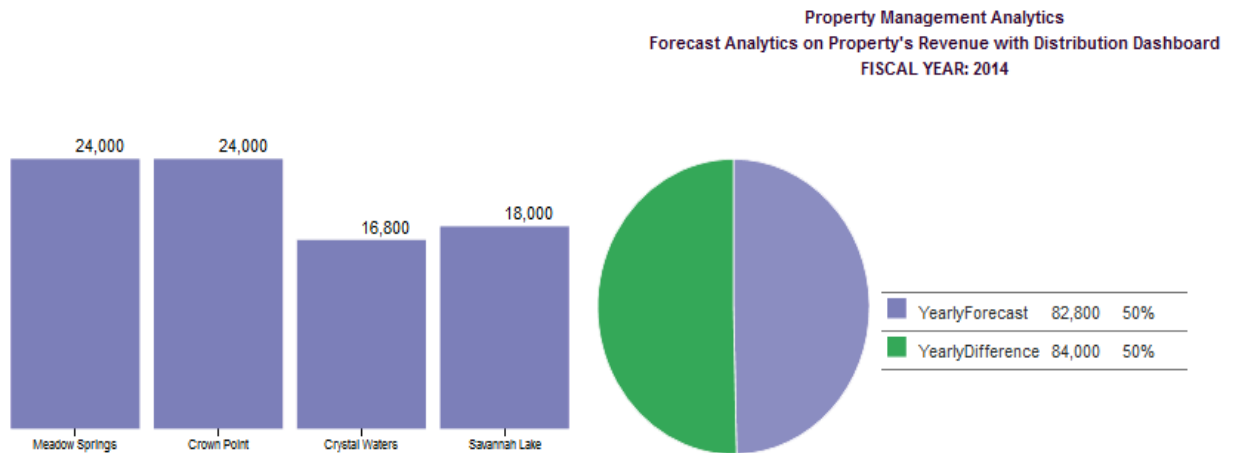
Figure36: Property Forecast Analytics, Mouse over to yearly Forecast on the Dashboard
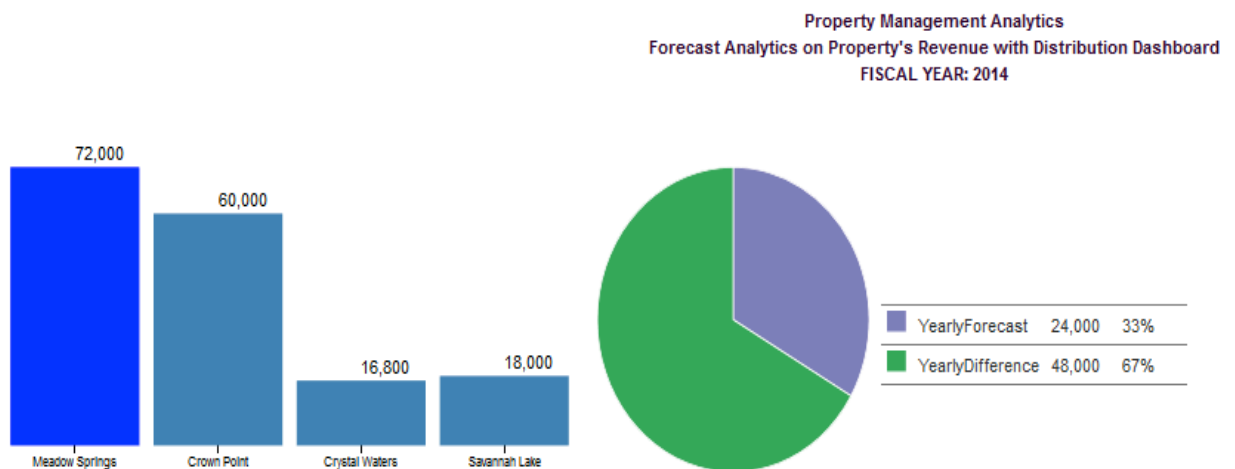
Figure37: Property Forecast Analytics, Mouse over to property Meadow Spring on the Dashboard

Figure38: Property Forecast Analytics, Mouse over to property Savannah Lake on the Dashboard

Property Earning Analytics: This dashboard contains three dimensional views. Using these analytics, management of this system could take appropriate financial decisions as needed corresponding to the budget and visualize the earnings vs differences by property as of current day. This uses the measures such as revenue loss due to vacate units or units not being under lease, actual revenue earned and pending revenue to collect.
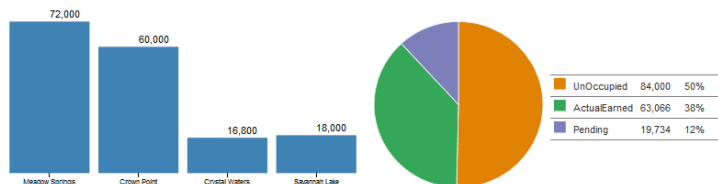
Figure 39: Property Earning Analytics Home page on selection of this Dashboard
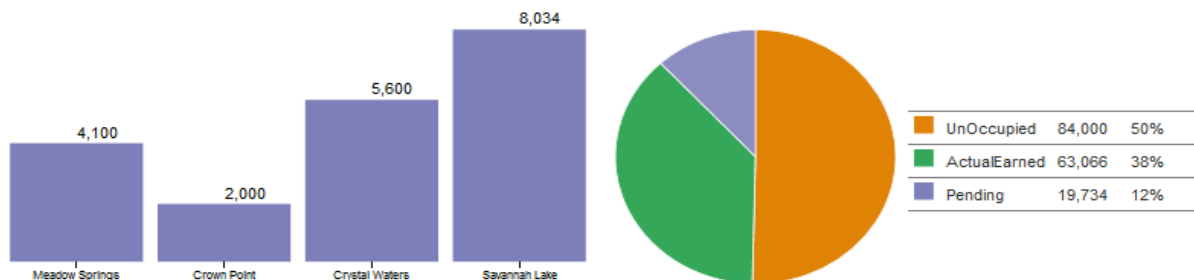
Figure 40: Property Earning Analytics Mouse over to Pending Income on the Dashboard
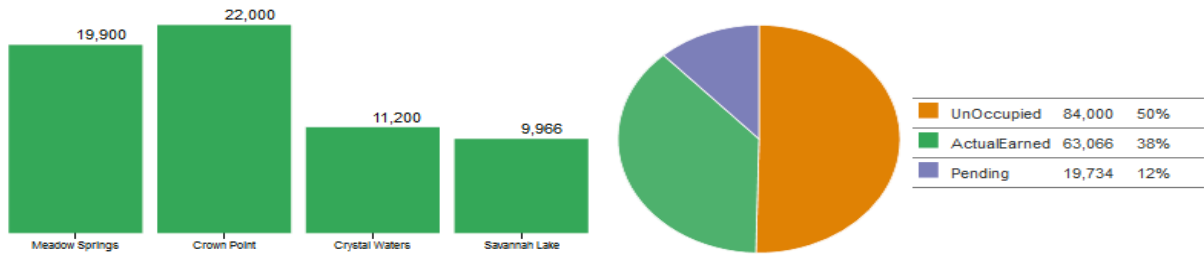
Figure 41: Property Earning Analytics Mouse over to Actual Earned Income on the Dashboard

Figure 42: Property Earning Analytics Mouse over to Unoccupied Income on the Dashboard

Figure 43: Property Earning Analytics Mouse over to Property Crown Point on the Dashboard
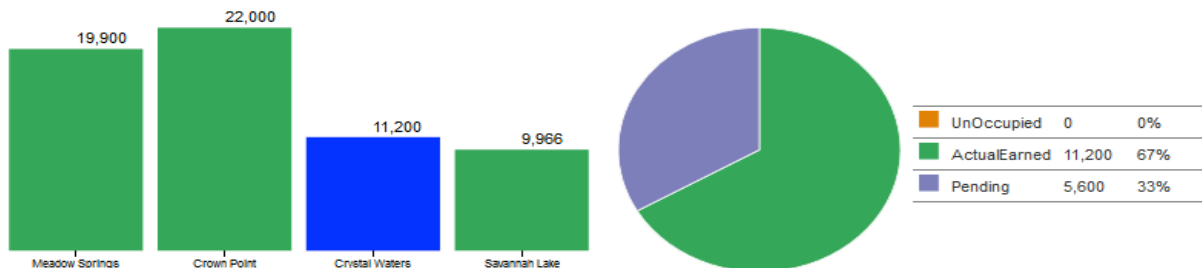

Figure 44: Property Earning Analytics Mouse over to Property Crystal Waters on the Dashboard

This plays a vital role in the financial segment of Property Management Analytics (OLAP) System. Mouse over to the appropriate property to visualize the measures of that corresponding property or for all properties including un-occupied, actual earned or pending.

Contact: This is the option where the users of one location could reach to the management by sending an email to the admin which will be redirected as needed based on the business policy.
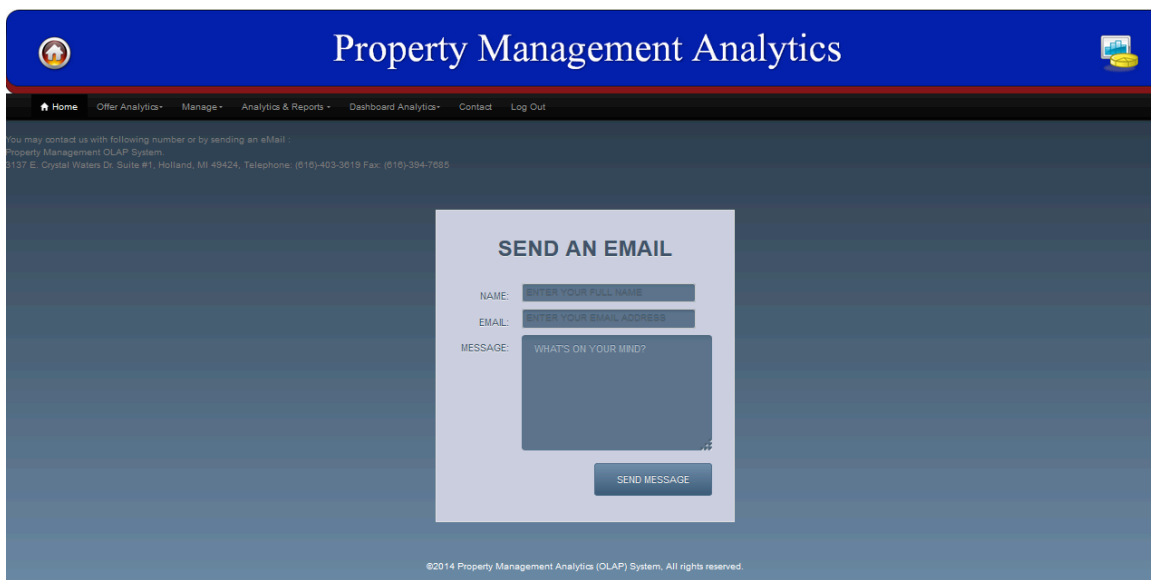

Figure 45: Contact Page of Property Management Analytics (OLAP) System