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Demand Bidding Program and Its Application in Hotel Energy Management

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By

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ABSTRACT:

Demand bidding program (DBP) is recently adopted in practice by some energy operators. DBP is a risk-free demand response program targeting large energy consumers. In this paper, we consider DBP with the application in hotel energy management. For DBP, optimization problem is formulated with the objective of maximizing expected reward, which is received when the amount of energy saving satisfies the contract. For a general distribution of energy consumption, we give a general condition for the optimal bid and outline an algorithm to find the solution without numerical integration. Furthermore, for Gaussian distribution, we derive closed-form expressions of the optimal bid and the corresponding expected reward. Regarding hotel energy, we characterize loads in the hotel and introduce several energy consumption models that capture major energy use. With the proposed models and DBP, simulation results show that DBP provides economics benefits to the hotel and encourages load scheduling. Furthermore, when only mean and variance of energy consumption are known, the validity of Gaussian approximation for computing optimal load and expected reward is also discussed.

INRODUCTION:

SEVERAL existing works on smart grid focus on energy management in home environment . On the other hand, the issue of smart grid integration into building environment is still largely unexplored. The role of buildings in smart grid was discussed in [4]. The paper elaborates several challenges such as multi-scale monitoring and control, occupancy sensing, data collection and management, and optimizing the operation of HVAC and IT equipment. In [5], a virtual building simulation platform together with model predictive control (MPC) was proposed. The MPC applies pre-cooling and peak load shifting which achieve the objective of economics saving under time-of-use pricing. A very recent work investigating smart grid with office building environment appears in [6]. Under real-time pricing scheme, the proposed scheduling at the device level provides significant economic savings in both with and without renewable energy unit. The results were obtained under living lab environment and take into account occupants' satisfaction. Another recent work addresses the battery design for buildings under uncertainties in solar radiation and demand profiles [7]. The problem was solved by the scenario tree method, which is a tool from stochastic optimization. In this paper, we are interested in the application of smart grid within lodging industry, especially the hotel industry. Our motivation is the fact that hotels are among the most energy intensive building category (after food services, shopping malls and hospitals) [8]. In the U.S. alone, the energy expenditure in the hotels reaches $4 billion annually [9]. Any successful attempt in reducing the energy consumption in hotels leads to a significant total amount of saving nationwide. Unlike other types of commercial buildings, hotel energy management presents its own unique challenges. First, energy consumption in guest rooms is normally in complete control by the occupants. Second, any attempts to control energy use in the guest rooms shall not compromise guest comfort. This presents a dilemma between saving energy cost and losing customer satisfaction. Third, utilities may apply time-of-use tariff that is not optimal for hotel energy use patterns. In addition, several other concerns for lodging industry to adopt smart grid technologies were discussed in. It seems rather obvious that smart grid for hotel energy management needs much further research. Future smart grid integrates demand response, where loads play major roles in

optimizing energy consumption patterns. A study in concluded that hotel is an excellent provider of spinning reserve. Preliminary testing suggested that up to 27% to 34% of loads can be curtailed depending on outside temperature . Real-time pricing (RTP) (hourly pricing) with manual operation in response was studied in. It was concluded that there was a substantial cost benefit in RTP but manual operation was labour intensive. Demand bidding program (DBP) is one type of demand response. It has been recently adopted in practice by Southern California Edison (SCE) and Pacific Gas and Electric Company (PG&E).DBP attracts large energy consumers to participate and encourages them to reduce their energy use by setting their own target. The customer is free to choose a bidding value in terms of the amount of energy reduction. If the actual amount of energy saving conforms to certain requirement, the customer will be rewarded. On the other hand, if the customer fails to reduce the energy according to the requirement, there is no financial penalty. This risk-free feature of DBP attracts interest of hotel managers since normally the energy consumption in a hotel is highly variable. Its dependency on occupancy rate (number of rooms booked) and other uncertainties such as weather condition, causes the hotels to hesitate in participating in other demand response programs which require strict commitment. In this paper, we discuss the DBP that is currently used in practice and formulate the corresponding mathematical optimization problem. Specifically, the problem is to determine the optimal bid that maximizes the expected reward subject to requirement of the operator. We provide a general condition for the optimal bid for a general distribution of energy consumption. Instead of numerical integration, this condition allows us to determine the optimal bid by using simple numerical method such as one-dimensional search algorithm. The general algorithm to compute the optimal bid is outlined. For the case of energy consumption that follows Gaussian distribution, we derive closed-form expressions for the optimal bid and expected reward, which can be easily computed without using numerical integration or optimization. Note that the term “demand bidding” is typically referred in purchase allocation problem in electric energy market [22]. On the other hand, demand bidding for electric consumers is relatively new. These two types of demand bidding are quite different in terms of features and purposes. Demand bidding in energy market consists in competition among bidders, incurs high risk, and aims to acquire energy. In contrast, demand bidding for consumers involves no

competition, no risk, and attempts to reduce energy consumption of large consumers.

INPUT DESIGN:

The input design is the link between the information system and the user. It comprises the developing specification and procedures for data preparation and those steps are necessary to put transaction data in to a usable form for processing can be achieved by inspecting the computer to read data from a written or printed document or it can occur by having people keying the data directly into the system. The design of input focuses on controlling the amount of input required, controlling the errors, avoiding delay, avoiding extra steps and keeping the process simple. The input is designed in such a way so that it provides security and ease of use with retaining the privacy. Input Design considered the following things:

- What data should be given as input?
- How the data should be arranged or coded?
- The dialog to guide the operating personnel in providing input.
- Methods for preparing input validations and steps to follow when error occur.

OBJECTIVES:

1.Input Design is the process of converting a user-oriented description of the input into a computer-based system. This design is important to avoid errors in the data input process and show the correct direction to the management for getting correct information from the computerized system.

2. It is achieved by creating user-friendly screens for the data entry to handle large volume of data. The goal of designing input is to make data entry easier and to be free from errors. The data entry screen is designed in such a way that all the data manipulates can be performed. It also provides record viewing facilities.

3.When the data is entered it will check for its validity. Data can be entered with the help of screens. Appropriate messages are provided as when needed so that the user will not be in maize of instant. Thus the objective of input design is to create an input layout that is easy to follow

OUTPUT DESIGN:

A quality output is one, which meets the requirements of the end user and presents the information clearly. In any system results of processing are communicated to the users and to other system through outputs. In output design it is determined how the information is to be displaced for immediate need and also the hard copy output. It is the most important and direct source information to the user. Efficient and intelligent output design improves the system's relationship to help user decision-making.

1. Designing computer output should proceed in an organized, well thought out manner; the right output must be developed while ensuring that each output element is designed so that people will find the system can use easily and effectively. When analysis design computer output, they should Identify the specific output that is needed to meet the requirements.

2.Select methods for presenting information.

3.Create document, report, or other formats that contain information produced by the system.

The output form of an information system should accomplish one or more of the following objectives.

- Convey information about past activities, current status or projections of the
- Future.
- Signal important events, opportunities, problems, or warnings.
- Trigger an action.
- Confirm an action.

SYSTEM ANALYSIS:

Existing System:

- It is limited to a single system.
- It is less user-friendly.
- It is having lots of manual work (Manual system does not mean that you are working with pen and paper, it also include working on spread sheets and other simple software's).
- The present system is very less secure.
- It is unable to generate different kinds of report.
- It doesn’t have the mail and file upload feature.

Proposed System:

The development of the new system contains the following activities, which try to automate the entire process keeping in view of the database integration approach.

- User friendliness is provided in the application with various controls.
- The system makes the overall project management much easier and flexible.
- It can be accessed over the Internet.
- Various classes have been used to provide file upload and mail features.
- There is no risk of data mismanagement at any level while the project development is under process.
- Report generation feature is provided using Crystal Reports to generate different kinds of reports like bar graphs, pie charts and table type charts etc.

It provides high level of security using different protocols like https etc.

IMPLEMENTATION

Implementation is the stage of the project when the theoretical design is turned out into a working system. Thus it can be considered to be the most critical stage in achieving a successful new system and in giving the user, confidence that the new system will work and be effective.

The implementation stage involves careful planning, investigation of the existing system and it's constraints on implementation, designing of methods to achieve changeover and evaluation of changeover methods.

Interaction Model:

1. Client-driven interventions

Client-driven *interventions* are the means to protect customers from unreliable services. For example, services that miss deadlines or do not respond at all for a longer time are replaced by other more reliable services in future discovery operations.

2. Provider-driven interventions

Provider-driven interventions are desired and initiated by the service owners to shield themselves from malicious clients. For instance, requests of clients performing a denial of service attack by sending multiple requests in relatively short intervals are blocked (instead of processed) by the service.

SYSTEM SPECIFICATIONS:

System Requirements:

Hardware Requirements:

- System : Pentium IV 2.4 GHz.
- Hard Disk : 40 GB.
- Floppy Drive : 1.44 Mb.
- Monitor : 15 VGA Colour.
- Mouse : Logitech.
- Ram : 512 Mb.

Software Requirements:

- Operating system : - Windows 7. 32 bit
- Coding Language : C#.net 4.0
- Data Base : SQL Server 2008

MODULES:

1. Hotel Master
2. Account Master
3. Inventory Master

Hotel Master:

The hotel management software provides you all kinds of masters that are in customizing mode so that your can add the things as per requirement like -

- You can decide masters for your hotel. The software gives masters for details of types of rooms, types of items in your hotel.
- The software holds the details of your hotel employees.
- Check IN OUT for the visitors.
- Cash receipt management.
- Credit card management.
- Preparing the telephone bill.
- Preparing the laundry bill.
- Making the room folio.
- Setting the automatic alarm of particular room.
- Complete and errorless reservation system.
- Daily business report.
- Occupancy at given time.
- Local call report.
- STD call report.
- Laundry report.
- Cash record.
- Food cost report.
- Staying guest credit report.
- Credit card report.

Account Master

- The hotel management software includes all principal heads of commercial field.
- We can also customize the heads per requirement.
- Unlimited accounts may be maintained through various heads.
- All necessary information of particular account is also kept.

- Ledger list.
- Ledger books with daily/summary options.
- Trial balance with closing balance and detailed options.
- Balance Sheets, quick view of current assets and liabilities.
- Reports of every head can also be generated on the closing and detailed based.

Inventory Master:

Hotel management software also provide facility to maintain complete inventory like:

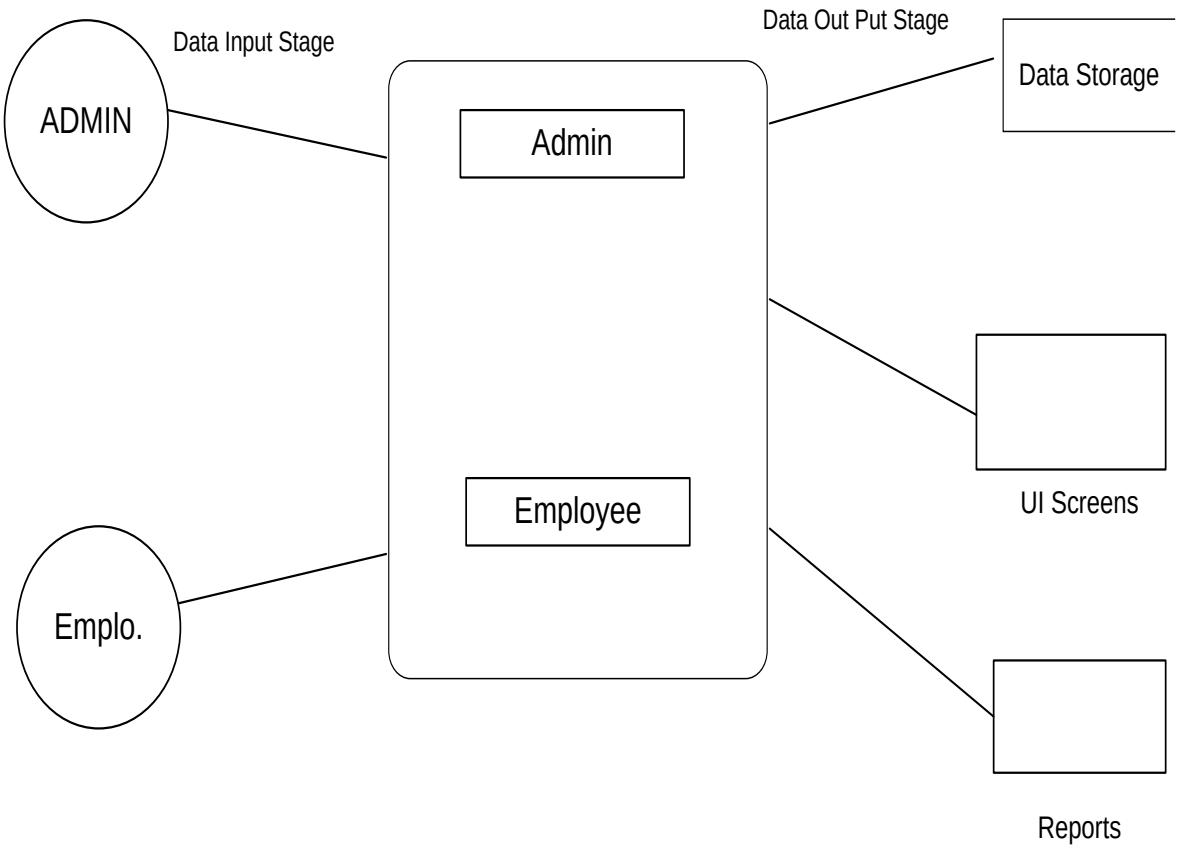
- Sale/ purchase data entry.
- Sale /purchase return.
- Stock report.
- Sale/purchase book.
- Stock ledger.
- Sale/purchase return book.
- Appointments list to inform you about your appointments.
- Address dairy that holds the address and additional information of a particular person.
- Dairy notes which records any note for a particular day.
- Memoranda, keeps personal information.
- Emergency list.

SYSTEM DESIGN

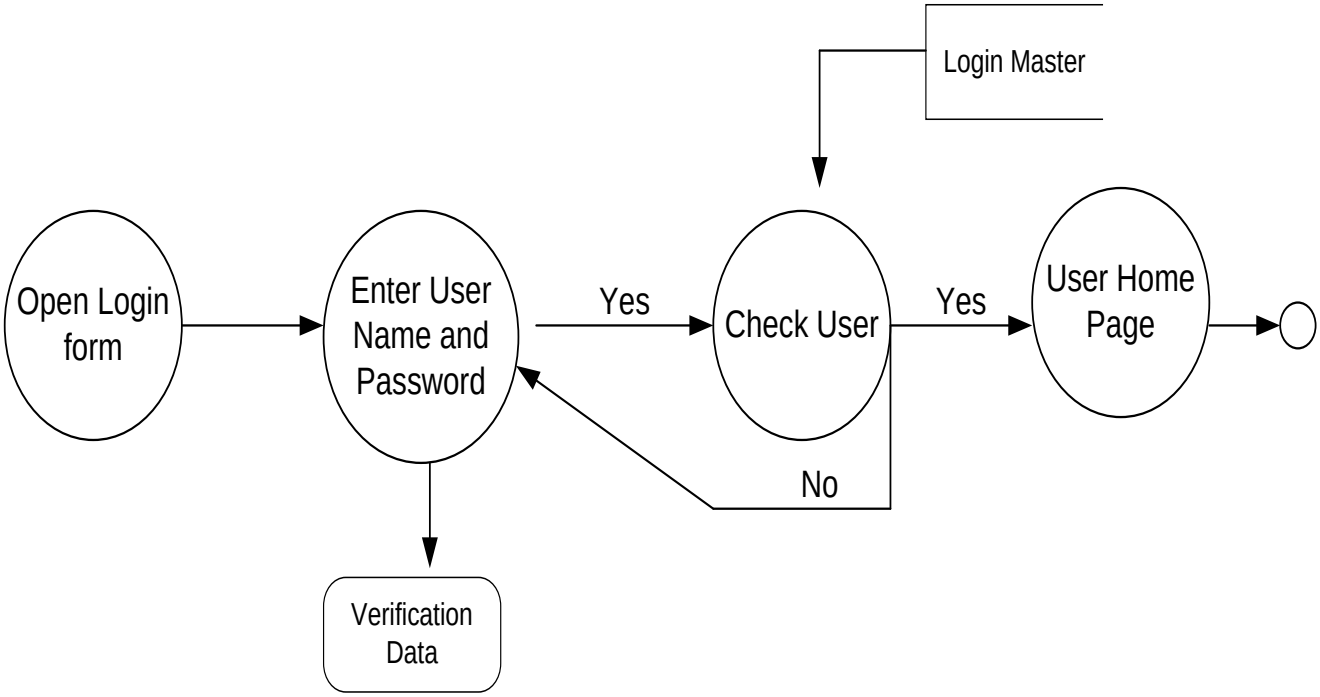
Data Flow Diagram / Use Case Diagram / Flow Diagram

The DFD is also called as bubble chart. It is a simple graphical formalism that can be used to represent a system in terms of the input data to the system, various processing carried out on these data, and the output data is generated by the system.

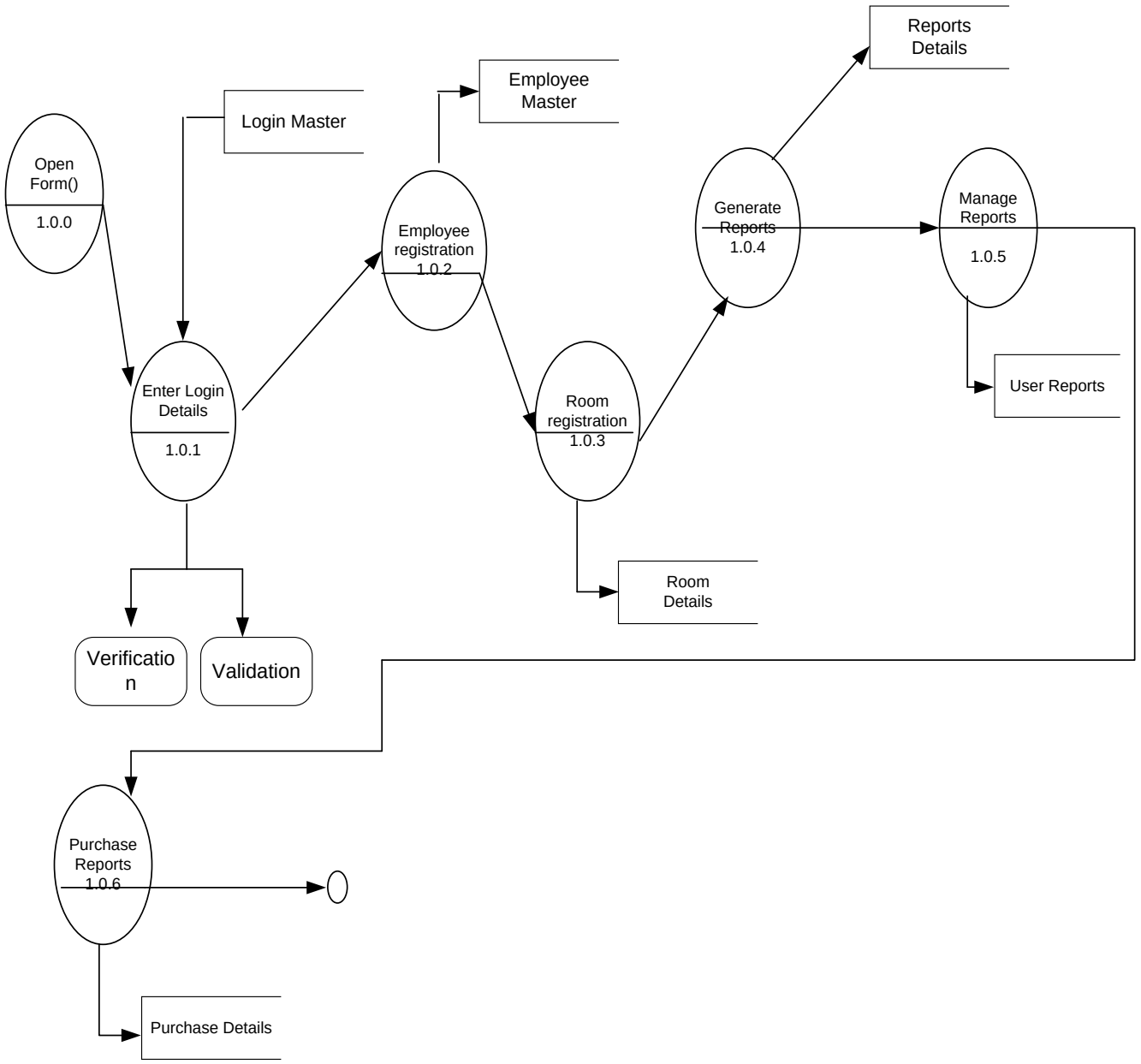
Hotel Management DFD's



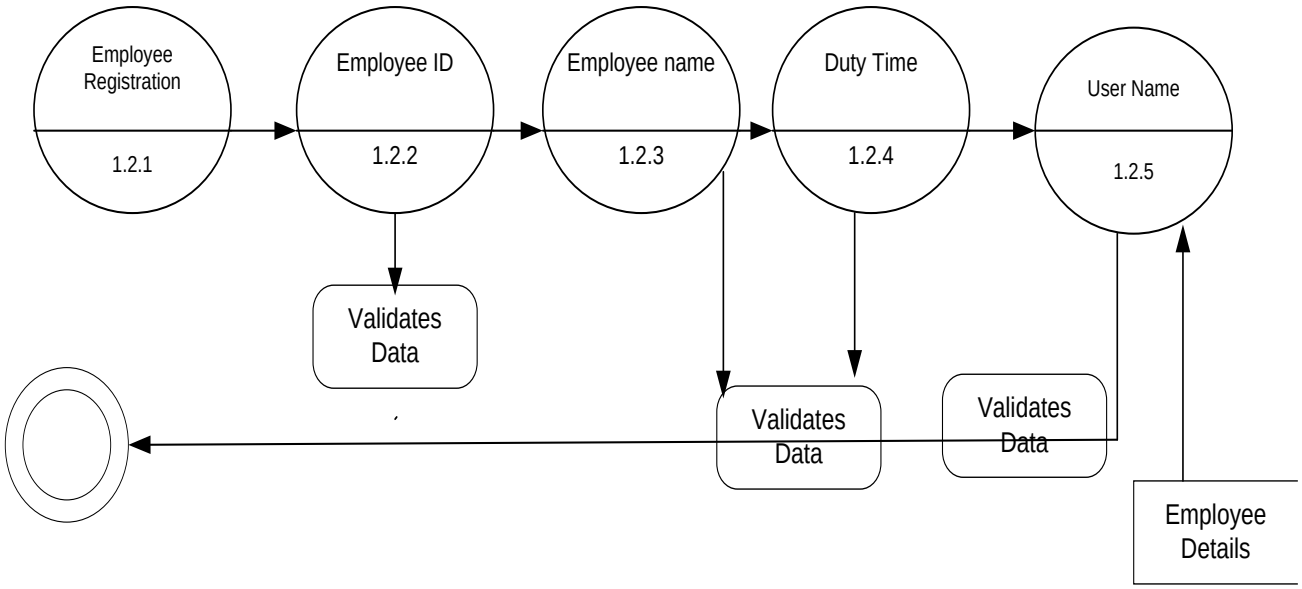
Login DFD


Login Master
Open Login form
Enter User Name and Password
Yes
Check User
Yes
User Home Page
No
Verification Data

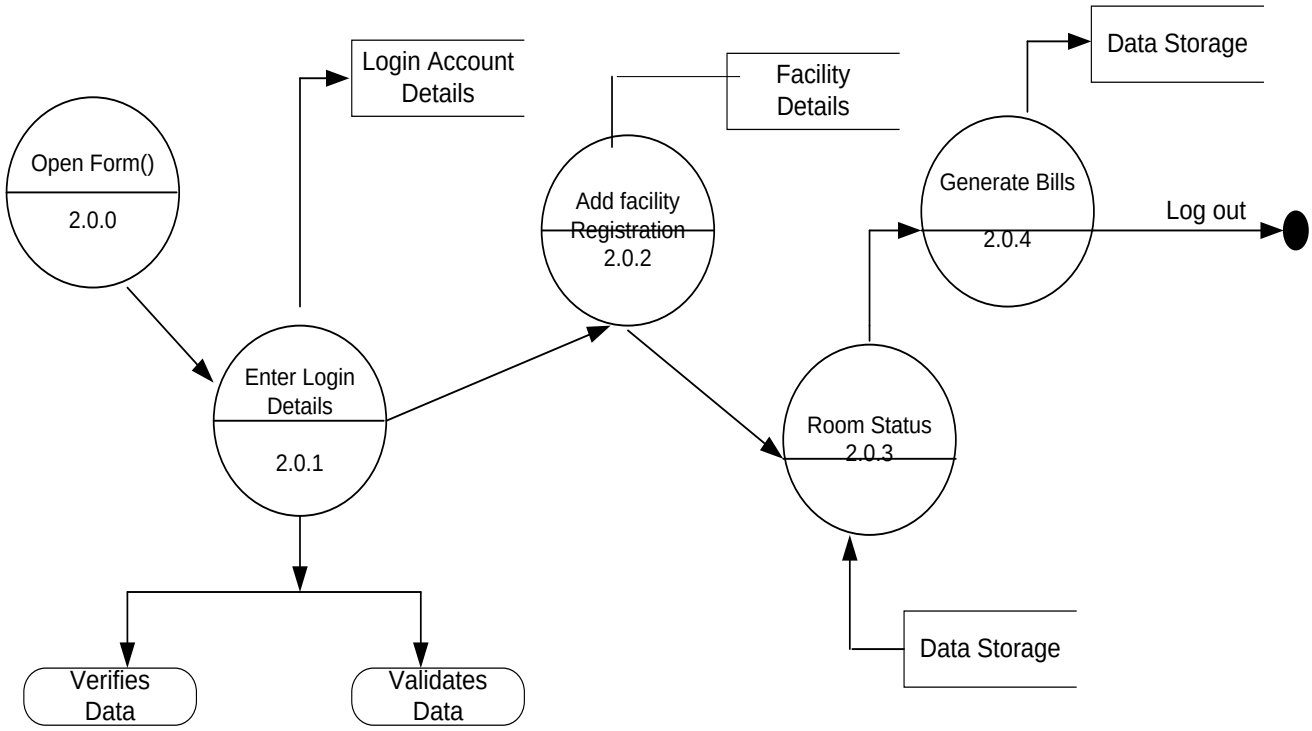
Admin Activities



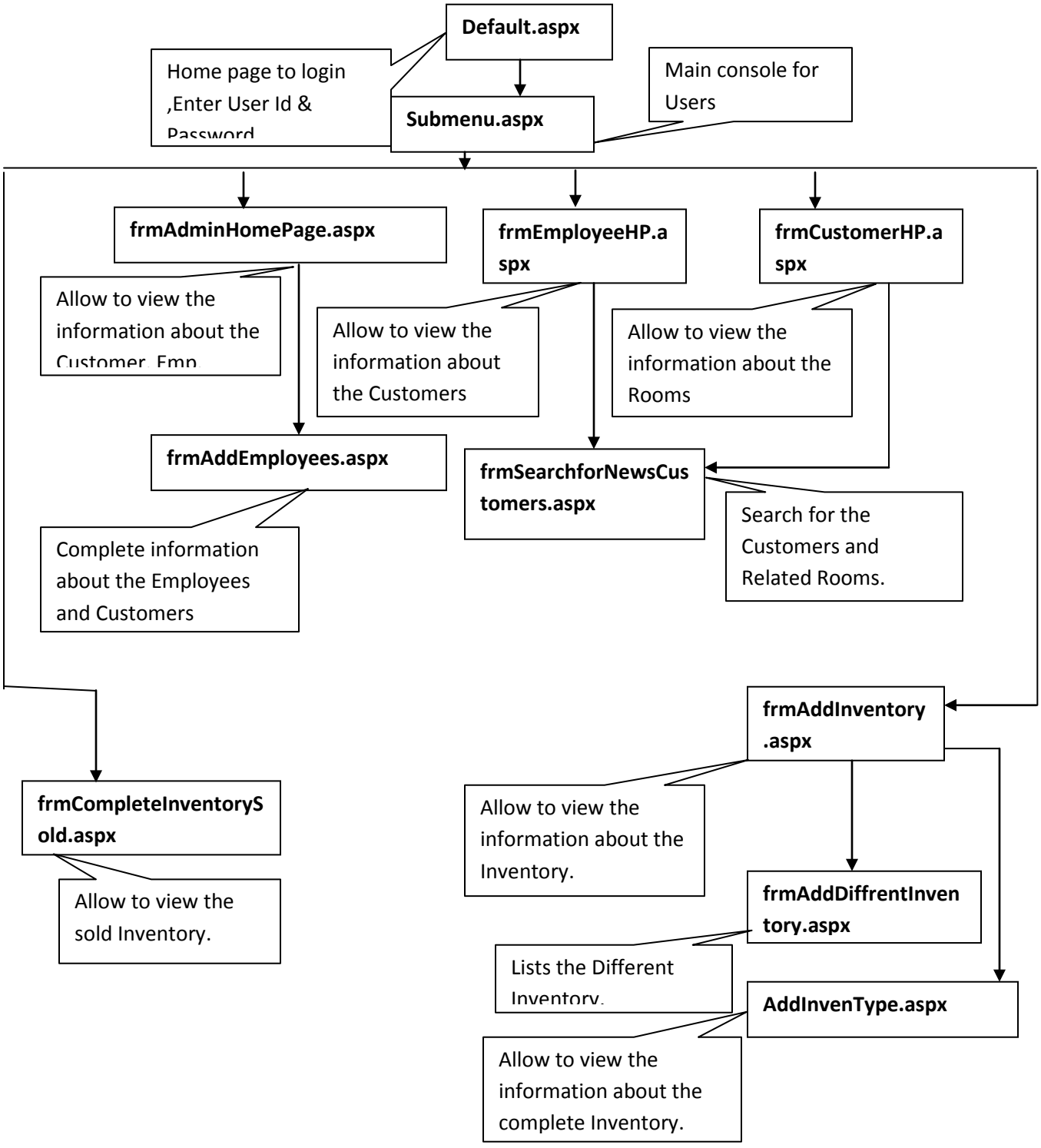
Admin Register Employee



User (Employee) Activities:



SYSTEM WORKFLOW



SYSTEM TESTING:

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the

Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

TYPES OF TESTS:

Unit testing:

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

Integration testing:

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

Functional testing:

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Functional testing is centered on the following items:

Valid Input : identified classes of valid input must be accepted.

Invalid Input : identified classes of invalid input must be rejected.

Functions : identified functions must be exercised.

Output : identified classes of application outputs must be exercised.

Systems/Procedures: interfacing systems or procedures must be invoked.

Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

System Testing:

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

White Box Testing:

White Box Testing is a testing in which in which the software tester has knowledge of the inner workings, structure and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black box level.

Black Box Testing:

Black Box Testing is testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box .you cannot “see” into it. The test provides inputs and responds to outputs without considering how the software works.

Unit Testing:

Unit testing is usually conducted as part of a combined code and unit test phase of the software lifecycle, although it is not uncommon for coding and unit testing to be conducted as two distinct phases.

Test strategy and approach

Field testing will be performed manually and functional tests will be written in detail.

Test objectives:

- All field entries must work properly.
- Pages must be activated from the identified link.
- The entry screen, messages and responses must not be delayed.

Features to be tested:

- Verify that the entries are of the correct format
- No duplicate entries should be allowed
- All links should take the user to the correct page.

Integration Testing

Software integration testing is the incremental integration testing of two or more integrated software components on a single platform to produce failures caused by interface defects.

The task of the integration test is to check that components or software applications, e.g. components in a software system or – one step up – software applications at the company level – interact without error.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

Acceptance Testing:

User Acceptance Testing is a critical phase of any project and requires significant participation by the end user. It also ensures that the system meets the functional requirements.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

CONCLUSION:

The paper investigates demand bidding program (DBP) under the context of hotel energy management. Optimization problem of DBP is formulated with the objective of maximizing expected reward. A general condition for the optimal bid is given and closed-form expressions of the optimal bid and the corresponding expected reward are derived for the case of Gaussian distribution. It is shown that the DBP provides economics benefit to the hotel and encourages the hotel to schedule the loads.

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