BSE20-25

LABOR OPTIMIZATION SYSTEM

Software Design Document

GROUP MEMBERS:

#	Names	Registration Number	Signature
1	MUWONGE EMMANUEL	16/U/7842/PS	
2	KISEMBO ERINAH TUMUSIIME	16/U/6168/PS	
3	MUTEBI WILSON	16/U/7751/EVE	
4	SUNDAY DEOGRATIAS	16/U/11792/PS	

Date: February, 19th 2020

Table of Contents

LIST OF FIGURES

LIST OF TABLES

1. Introduction

1.1. Purpose

This document's purpose is to provide a high-level design framework around which to build our Labor Optimization System. This document will define the design of the Labor Optimization System. It contains specific information about the expected input, output, classes, and functions. It also provides a list of requirements against which to test the final project and determine whether we were able to successfully implement the system according to design.

1.2. Scope

This Design Specification is to be used by Software Engineering and Software Quality Engineering as a definition of the design to be used to implement the Labor Optimization System]. It provides the architecture and design of Release 1.0 of the Labor Optimization System. It will show how the design will accomplish the functional and non-functional requirements detailed in the Labor Optimization System Software Requirements Specification (SRS) document.

1.3. Overview

Product Perspective

This product will contain an intelligent model that will help organizations optimize labor at their disposal by making predictions on labor output and need for a particular period of time based on a certain learnt pattern.

Design Method

The design of this product utilizes an object-oriented approach.

User Interfaces

The user of this product will be interfacing with the system to help put in some inputs when required. The product allows the user to get familiar with the software with the least computer knowledge.

Hardware Interfaces

This software can run on most computers with compatible graphics card which is required due to need of graphical visualization of the analysis.

Software Interfaces

This system will execute on all operating systems platform through a browser connected to the internet.

Memory Constraints

This program takes up about 7 kB of memory. The output results are modest in size and take up about 7 kB.

Operations

The user will be required to enter the parameters/values for the system from the user interface.

Site Adaptation Requirements

This software is intended to execute on any operating system platform with no modifications needed to support different sites.

User Characteristics

The general characteristics of the intended users are computer literates and people with some knowledge about labor related information.

1.4 Reference Material

None

1.5 Definitions and Acronyms

1. kB: Kilobytes
2. LOS: Labor Optimization System
3. UBOS: Uganda Bureau of Statistics

2. SYSTEM OVERVIEW

The Labor optimization System will provide a solution to the problem of labor underutilization and labor over utilization in many organizations in Uganda which may at first not seem as a big issue to business and yet it actually is.

Labor is a factor of production and therefore it equally affects the growth of a business just as much as any other factors such as capital and land. Labor as a resource is mainly measured in terms of labor productivity which is a key measure for business efficiency. [1] Uganda has lowest labor productivity of 1,085 in comparison to its neighboring countries (Tanzania 2,016; Zambia 2,680; Kenya 3,457) in terms of value added per worker in US dollars. This therefore lowers the economy of the country despite the fact that we are undergoing the industrial revolution. [2] Following the National Employment Policy of the republic of Uganda which states that Increasing Decent Employment Opportunities and Labor Productivity for Socio - Economic Transformation, this much more causes a great need for the improvement of the labor productivity as this is of great importance to both the business and the country at large[3].

The UBOS report suggests use of technology as one of the solutions to the decrease in labor productivity. The LOS system will be developed to provide a solution to the problem in the above paragraph. It will be a web based system with a machine learning predictive model that can predict the amount of work and distribute it basing on the labor available. It will also help in the business analysis[4].

3. SYSTEM ARCHITECTURE

3.1 Architectural Design

The Labor Optimization System will function in such a way that the software draws data from the database which will then be ran through our predictive model. This predictive model will then predict the possible result for a query made by the user and project the outcome to the user interface.

Figure 3. 1 Architectural design of LOS
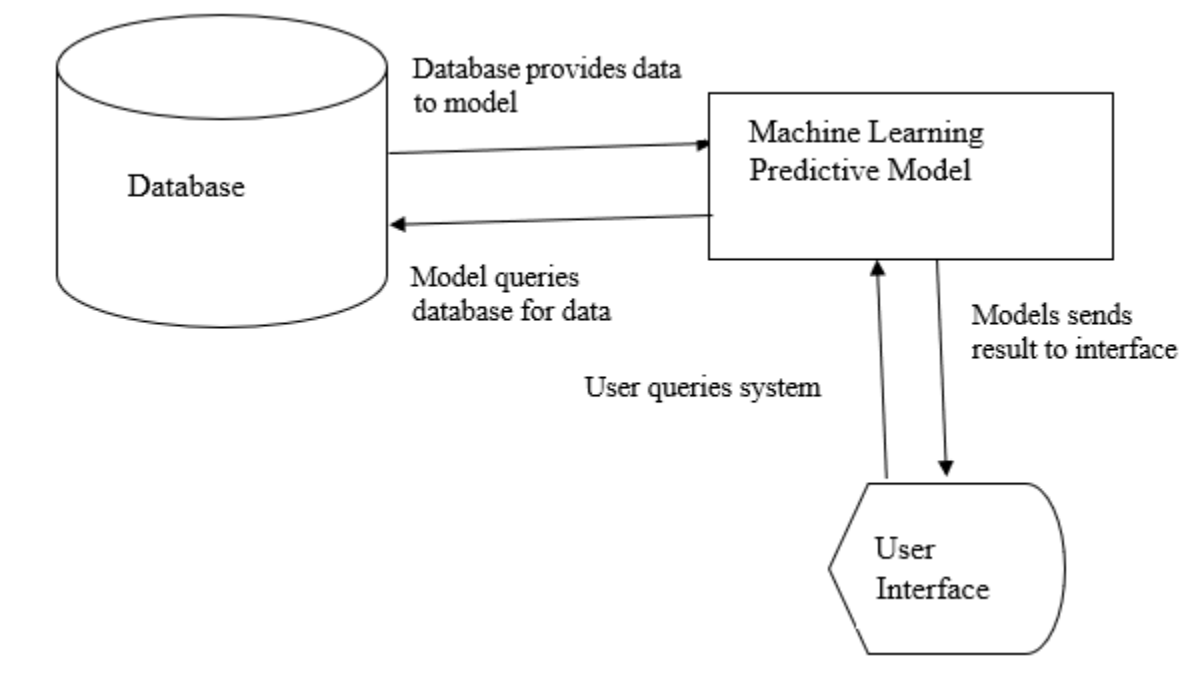
The System comprises of mainly three modules that is;

The User Interface: This is meant to enable the user interact with the system. This will provide the user with a mechanism of querying the system with specific instructions and all displaying the results of the query in a more understandable way to the user.

Database: This provides a mechanism with which the records of the employees are going to be collected overtime. This meant to enable the system work and predict with a view of following the current trends in the data of the employees

The Machine Learning Predictive Model: This is our artificial intelligence setup that is meant to use the data stored in the database by analyzing it and drawing various conclusions about the future that are viable to coming up with necessary decisions in labor management.

How they work

The user accesses the user interface and queries the system to do something. The user interface sends the query to the model. The model accesses the database and retrieves the necessary data to perform the user's request. The model processes the query and sends the result to the user interface where the user views and makes the intended decisions based on the system's output.

3.2 Decomposition Description

Figure 3. 2 Context diagram of LOS
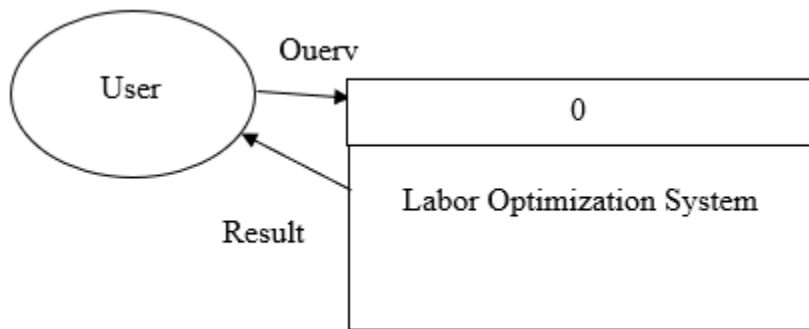
The user queries the system. The system queries the employee database for the information needed to carry out the specified query. The database provides the data. The system analyses the data using the predictive model and displays the outcome to the user.

Figure 3. 3 Structural decomposition diagram of LOS
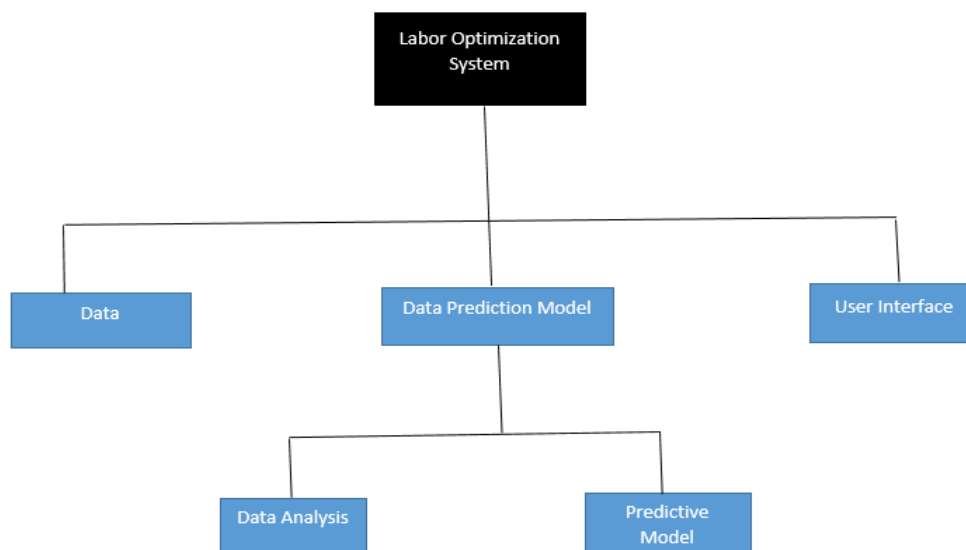
3.3 Design Rationale

We used three-tier architecture with a logical layer of the data prediction model and a user interface and a database. We chose this architecture because it provides a means of continuous improvement of the model with data being fed into the database and a means to analyze and predict the outcome before displaying it to the user through the user interface.

4 DATA DESIGN

4.1 DATA DESCRIPTION

The data will be flowing through four different modules of the system that is the web interface, predictive model, data analysis and data base modules.

Each module will be implemented as a function and it will allow flow of data in out of the module using various parameters and variables.

The data will be stored in the MySQL relational database and it will be used for analysis and training the predictive model. This data will be mainly captured from the user at web interface as input by the user and then stored in the database. The data from the database will be first exported to the csv file and then used to train the predictive model at a given interval.

The Entity Relationship Diagram

Figure 4.1 Entity Relationship Diagram
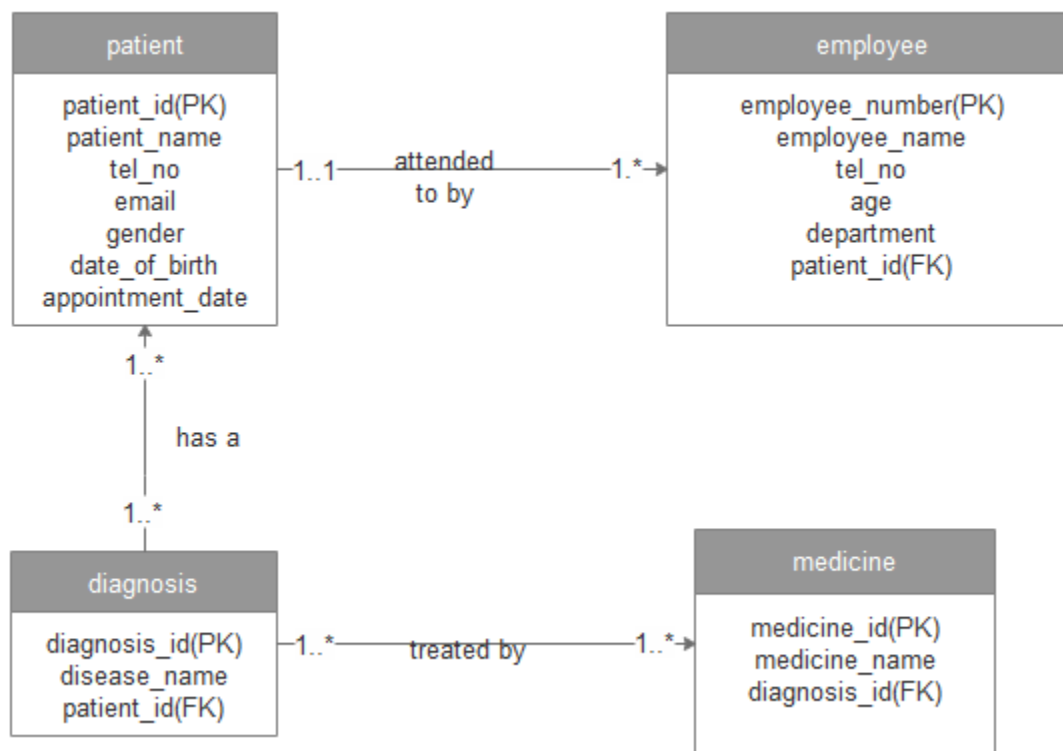
4.2 DATA DICTIONARY

The dictionary shows the tables in the database and how the various fields are to be stored.

Table6. 1THE PATIENT TABLE IN THE DATABASE

NAME	FIELDS	TYPE	DESCRIPTION
PATIENT	Patient_id	integer	Unique identification for each patient
	Patient_name	varchar	Name for each patient
	Tel_no	varchar	The telephone contact of the patient
	email	varchar	The email address of the patient
	Date_of_birth	date	The patient's date of birth
	Appointment_date	date	The patient's date of appointment
	Gender	varchar	The patient's gender

Table6. 2 THE EMPLOYYE TABLE IN THE DATABASE

Name	Fields	Type	Description
Employee	Employee_number	integer	Unique identifier of all the employees in the hospital
	Employee_name	varchar	The employee's name
	telephone	varchar	The employee's telephone contact
	Age	integer	The employee's age
	Department	varchar	The employee's department in the hospital

Name	Fields	Type	Description
Medicine	Medicine_id	int	Unique identification of medicines in the hospital
	Name	varchar	The name of the medicine

Name	Fields	Type	Description
Diagnosis	Diagnosis_id	int	Unique identifier to the disease the patient has been diagnosed with
	name	varchar	Name to the disease the patient has been diagnosed with.

5. Component Design

5.1. User Interface Component

5.1.1. Definition

A component that displays detailed results from analysis conducted. It also displays the results from the predictive model component.

5.1.2. Responsibilities

- Display analysis and prediction results.
- Provide interface for end user interaction with the system.

5.1.3. Constraints

- Requires a browser
- Changes made here shouldn't affect the system.

5.1.4. Composition

Contains exported graphs and statistical figures. It can also consist of a browser.

5.1.5. Uses/ Interactions

This component interacts with the Predictive model component by getting analysis results from the latter.

5.1.6. Resources

- Hard disk
- RAM
- Processor

5.1.7. Processing

Here analysis results are graphically displayed on the monitor for the users to view. Stimuli generated by user clicks are transferred to the Predictive model component for response generation.

5.1.8. Interface

A graphical user interface with clickable buttons and menus are provided to facilitate user friendliness and interactions with the end users.

5.1.9. Typical Operation Flow (Pseudo code)

User selects display type;

If analysis results is selected;

        User selects analysis results type;

                If statistical table is selected;

                        Render Table;

                If graph is selected;

                        Render Graph;

Else if predictive results is selected;

        User selects preferred time range;

        User selects typical tasks and other preferred prediction outputs;

        Render Predictive Output;

When user is done;

        Close Session;

5.2. The Machine Learning Predictive Model component

5.2.1. Definition

This component conducts analysis on the dataset and also performs machine learning aided predictive modeling.

5.2.2. Responsibilities

- Import dataset from where they are stored.
- Create new datasets from existing ones.
- Conduct analysis on imported datasets.
- Perform relevant predictive modeling.

5.2.3. Constraints

- Only accessible to developers.
- Requires availability of reasonable space on Main Memory.

5.2.4. Composition

It has machine learning scripts.

5.2.5. Uses/Interactions

It imports data from the Dataset/Database component and displays analysis results in the User Interface component. It is also used by developers when working on the system.

5.2.6. Resources

- Hard disk storage
- RAM
- Processor

5.2.7. Processing

Machine Learning scripts are executed to produce results.

5.2.8. Interfaces/Exports

The main interfaces here are the script window and the console. The exported item from this component is analysis results to the User Interface component.

5.2.9. Typical Operation Flow (Pseudo code)

Fetch dataset from where it is stored;

Clean dataset;

Perform statistical analysis to get general outlook and overview of the dataset;

Use employees previous leave records to predict who will likely take leave in which period;

Use past workload information to predict the amount of workload over a range of time period that is on a particular day, in a week, in a month, in a year; (All these options have to be available for the user selection during interaction.)

Use workload and employee details to predict which areas might need man power improvement and in what quantity;

Render analysis results in tabular and graphical formats;

Render prediction results in tabular and graphical formats;

5.3. Database component.

5.3.1. Definition

This component contains the dataset(s) to be analyzed.

5.3.2. Responsibilities

Store the dataset and other datasets that may be created during the course of development. It acts as a feeder to the Machine Learning Predictive Model component.

5.3.3. Constraints

- Requires physical storage space.
- End users can't interact with this component. This is to avoid them altering the content of the dataset

5.3.4. Composition

It contains dataset and other datasets created by developers.

5.3.5. Uses/Interactions

It interacts with the Machine Learning Predictive Model component. The latter imports the dataset from here.

5.3.6. Resources

It uses the physical storage (The hard disk).

5.3.7. Processing

The datasets are imported from it using scripts written in the Machine Learning Predictive Model component.

5.3.8. Typical Operation Flow (Pseudo code)

Establish Database Connection;

Create Database If Doesn't Exist;

Select query type;

    Case inserts data:

        Prepare data to insert, d;

        Insert Data;

    Case update table:

        Update Table;

    Case deletes data:

        Delete Data;

    Case fetches data:

        Fetch Data;

Close Connection;

6. Human Interface Design

UI is designed according to UI design principles.

The structure principle: UI is organized in such a way that related things are combined together and unrelated things are separated.

The simplicity principle: It is easy to follow the provided interface. In the case of mistake, system displays error message.

The visibility principle: All system's functions are available through UI. It does not overwhelm users with too many alternatives.

The feedback principle: Through the system of messages, the design keeps users informed of actions, errors, or exceptions.

The reuse principle: In design, same names were used to perform the same operations with different objects in order to reduce ambiguity.
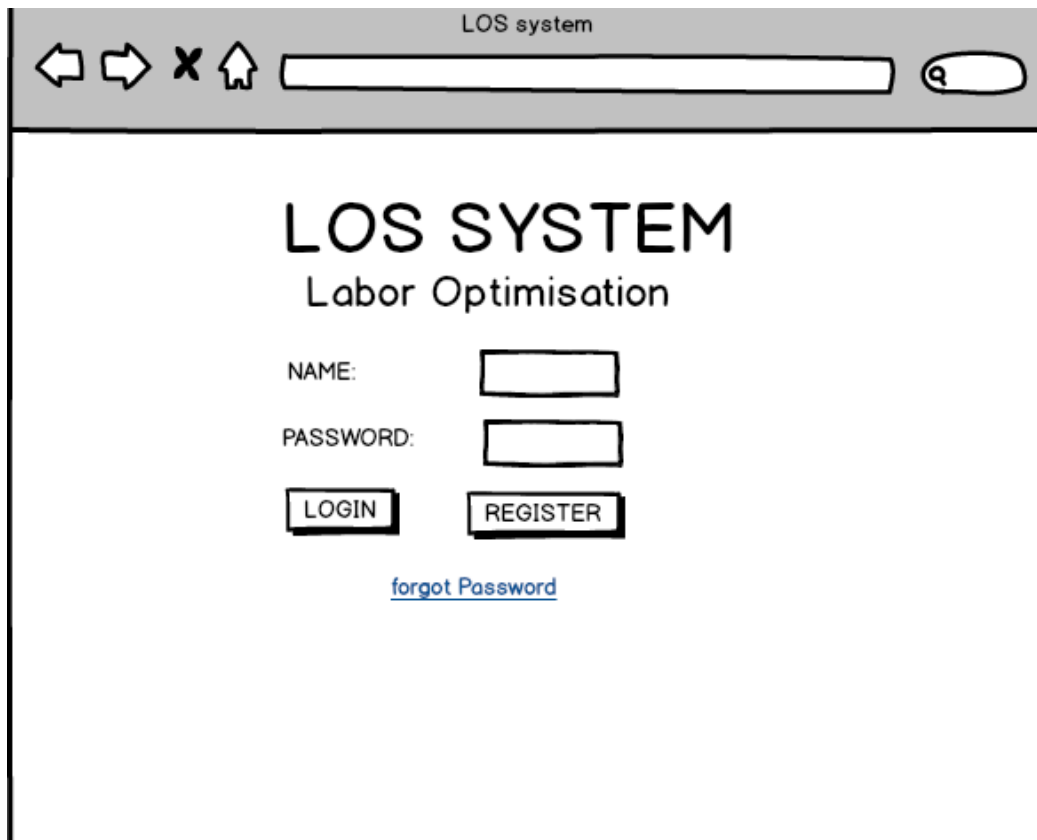
6.1 Overview of User Interface

The landing page is the login page that authorizes and authenticates users into the system. From the login page, the user can reach the home page only after successfully logging in. From the home page, the user can reach several other pages that include: data analysis, help, workload and labor needed pages. All these pages cover necessary functionality of system. It is easy to navigate between these pages. User constantly has access to all pages through the menu on top of each page. Each page has its own menu on the left side of the page, which contains all required operations that could be performed with that page.

Login page has descriptive characters; it contains a list of main system's functionality and contact information. After login, Home page is displayed and guides user on how to work with system. Home page covers main functionalities of the system.

6.2 Screen Images

Used GUI components are menus, submenus, buttons, textboxes and checkboxes, down drop lists, links, and tables. The only means of access to the entire database, by all users, is through this UI. Some examples of UI are presented below:

Figure 6. 1Login Page of the LOS System

Figure6.2 Home Page of the LOS System

Figure6. 3 Screen showing workload for a given week

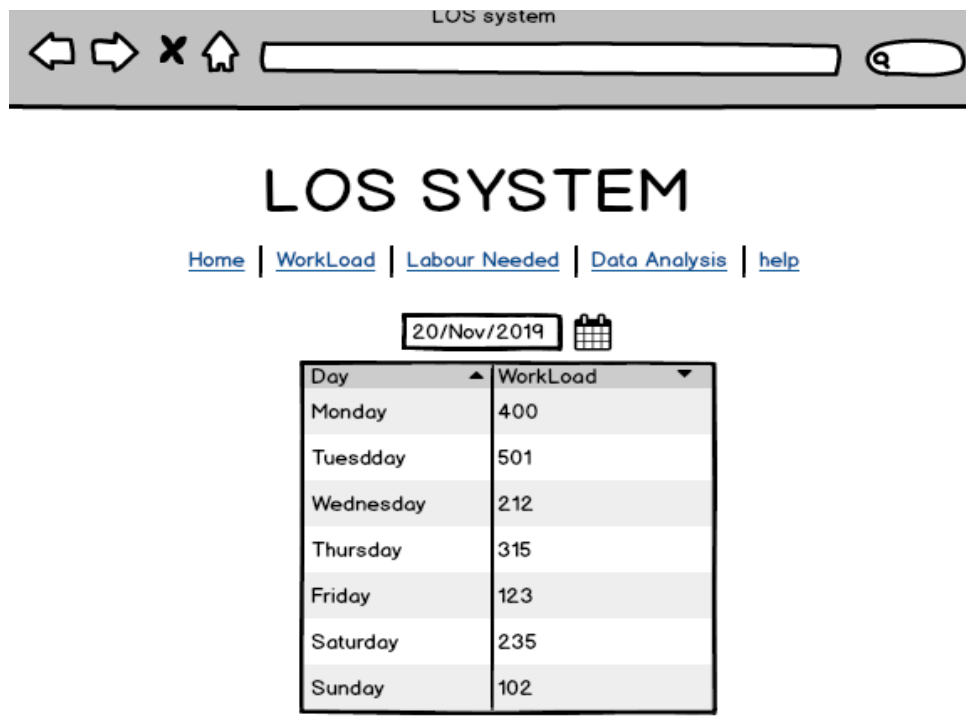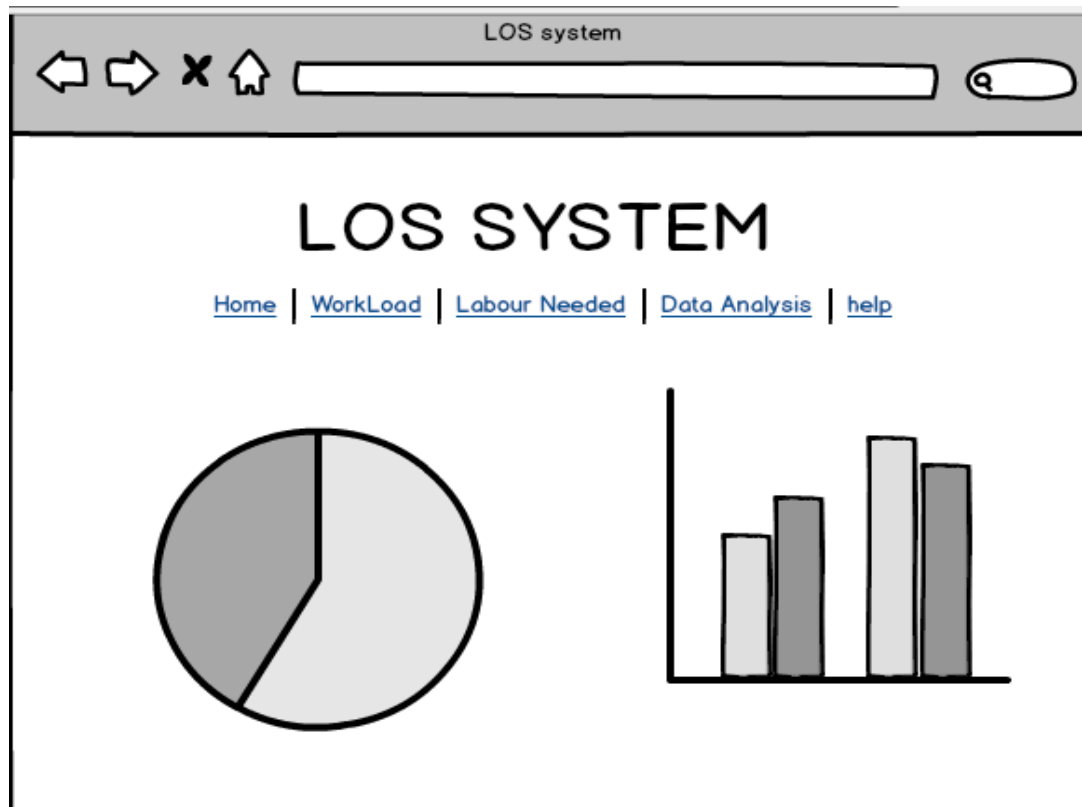*Figure6. 4 Data Analysis interface*

6.3 Screen Objects and Actions

In the Login page, user provides login and password in appropriate text boxes and confirms this operation, clicking on Login button.

After logging in, Home page is available to user. It contains following menu: Home, Workload, Labor Needed, Data Analysis, Search and link to Logout the current user. User clicks on necessary item in the menu in order to navigate to the next page.

Search button allows user to perform Basic and Advanced searches. User inputs keyword to be searched in the text box and then clicks the Search button. Results of the search are then displayed back to the user.

Workload Page has a time menu (Hours, Days, Monthly and Yearly) on left side of the page and a text input to specify the quantity of the time for which the prediction can be made. When any of the menus is clicked, a predictive machine learning model is invoked to make predictions. The prediction results are displayed on the interface in a well formatted table.

Labor needed page has the same menu as the Workload page since its content greatly depends on the predicted workload. When clicked, it displays the number of employees in the selected number of time unit to perform the predicted workload.

Data analysis page has a menu of three (3) items (All, Employees, Workload records) on left side of the page and a text input to specify the quantity of the time for which the prediction can be made. The All menu which is the default displays analysis of both employees' trends and workload records over a given period of time indicated in the text input. This page purely displays visualization of the data that is graphs and tables.

7. REQUIREMENTS MATRIX

Table7. 1Requirements Matrix

REQUIREMENTS	SYSTEM COMPONENTS
LOS shall predict the number of customers expected by the organization for a specific period of time	The Machine Learning Predictive Model component
LOS shall analyze some of the data recorded overtime	The Machine Learning Predictive Model component
LOS shall provide visualizations of the data recorded overtime	The Machine Learning Predictive Model component
LOS shall allow users to register	User Interface Component
LOS shall predict the number of employees required for a given task for a given period of time that is a day, week or month	The Machine Learning Predictive Model component
LOS shall allow users to login	User Interface Component

References

[1]   G. Ssemogerere, *Productivity Performance in Developing Countries*. 2009.

[2]   *THE NATIONAL EMPLOYMENT POLICY FOR UGANDA.* .

[3]   "No Title." [Online]. Available: https://newz.ug/uganda-will-not-achieve-middle-income-status-with-the-current-low-labour-productivity/.

[4]   Ubos, *Report national labour force survey*. 2017.