INTRODUCTION

This study was conducted at a local hospital in Cameroon, the Regional Hospital Limbe (RHL), and aimed at attempting one of African major problems; queues systems with long queues, using health care systems as a study [3]. It concentrated on the application of queuing analysis and prediction of waiting time at (RHL). The work was a mix of concepts, using machine-learning techniques together with queuing theory concepts and their associated simulations. The main purpose of the work was to be able to make mathematical sense of a real-life scenario concerning queues (waiting lines), and try to come up with models for performance measures and improvements [3]. In terms of machine learning methodology, the problem was a supervised regression problem, which fit a model using the Random Forest Regressor [2]. In order to predict waiting time spent by a patient in a queue on any other day, random forest were used for predictions, outlining the waiting time for a given day, provoked variables like department, among other variables. From results, the model predicted a patient waiting in queue before receiving service was predicted with an average of 10.3 minutes of error (MAE), and as a verifier of methods, the model for total time spent in system had .77 minutes of error (MAE). Additionally, important variables in predicting both waiting times and total time spent in the system were identified. The work, through machine learning techniques, was thus able to predict how long a patient can wait in the hospital before receiving service and the total time from arrival until leaving the system.

Aim of the study

1. To decrease patient waiting time.
2. To predict the amount of time a patient spends before receiving service in future.

Research questions

In this project, the main aim was to study the queues with the following research questions;
1. What is causing the queues?
2. Which are the busiest departments, busiest days and busy times of the day?
3. How is the queuing system performing in terms of waiting and service times? Is it efficient enough?
4. Is it possible to have patient time predictions for the future?

DATA AND METHODOLOGY

Data

• Primary data collected through questionnaires and observations.
• Secondary data collected through hospital registers.
Response rate for patients: 84% and 32 refusal cases.
Response rate for medical personnel: 100%.

Methodology

• The problem was a supervised regression ML problem.
• Under ML, the learning algorithm used for prediction was random forest.
• The random forest worked by building and merging several decision trees in order to obtain a more accurate and stable forecast for waiting and total time in the hospital.
• Predictions for both waiting and total time spent were made using the Jupyter notebook in python, mainly to check the possibility of predicting the waiting and total time a patient spends in the hospital on any other day and model accuracy.
• The observed data was split into 3 train data and 1 test data.
• Model fitting using the Random Forest Regressor, initially had 1000 decision trees which were further trimmed for simplicity.
• For measuring prediction accuracy/error size, measures like Mean Absolute Error (MAE) and Mean Absolute Percentage Error (MAPE) were used to find error size and describe the average error and error size to be expected from the forecasts.

RESULTS

General overview

![Average w-time vs number of patients](image1)

Figure 1: Average w-time daily

![Average w-time vs number of patients](image2)

Figure 2: Average w-time vs number of patients

![Correlation matrix](image3)

Figure 3: Correlation matrix

![Variables for waiting time prediction](image4)

Figure 4: Variables for waiting time prediction

![Variables for total time prediction](image5)

Figure 5: Variables for total time prediction

![Total time prediction](image6)

Figure 6: Total time prediction

![Total time prediction](image7)

Figure 7: Total time prediction

CONCLUSION

Any patient to visit RHL can use the proposed model to forecast the amount of time they will spend in the system.

RECOMMENDATIONS

1. To predict amount of time to be spent in the hospital at RHL, check and confirm day and time to visit, department and number of people that already exist in the system.
2. Change queuing system: one queue-multiple server.
3. Seek exemptions for doctors on duty for morning meetings, ward rounds and emergencies.
4. Increase doctors/shift and dedicate different server for patients requiring shorter services.
5. Specialists: Introduce consultation by appointment.
6. Combine steps for triage with screening points.
7. Compute payment system to avoid hand invoicing.
8. Produce results in two shifts for the lab.

Any patient to visit RHL can use the proposed model to forecast the amount of time they will spend in the system.

REFERENCES

