PREDICT QUEUE WAIT TIME IN A HOSPITAL ENVIRONMENT

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Abstract —Inefficient management of the patients‟ queues are one of the major issues faced in medical institutions like clinics and hospitals which end up in creating large crowds at the hospital lobbies and an extended waiting time in the patients‟ treatments. Waiting unnecessarily for a long period of time, ends only in loss or wastage of time, human life, and hospital resources. It also increases the number or frustrated patients that are waiting to get treatment required. Every single patient must undergo a diagnosis and then be forwarded to other departments or medical personnel for further procedures. Therefore, each patient's waiting time is the time taken by the system to diagnose all the patients before him/her in the queue. In such a condition, the most practical decision would be to give out an efficient treatment plan to each patient. This can be implemented as a mobile application, wherein a predictable waiting time according to the diagnosis of the patient is uploaded, which then updates itself in real-time. Taking this into consideration, this paper proposes a Patient Treatment Time Prediction (PTTP) algorithm that can predict the time taken by a procedure for a particular patient. This algorithm can be applied to real world scenarios and can be implemented in a large-scale environment. After predicting a treatment time necessary, the Hospital Queuing Recommendation (HQR) system can be developed. The necessary input data for this is taken from a real-world scenario like an actual doctor estimating time for a procedure at a particular hospital.

Keywords- PTTP, Estimation time, queue system; web application; Health facilities.

I. INTRODUCTION

Nowadays, the patient overcrowding and ineffective management of the patient queue are the major problems faced by the hospitals. Managing the patient queue and predicting the wait time of the patients in the hospital has become a difficult job because each of the patients may need to undergo different kinds of operations, such as general check-up, CT scanning, sugar level test, blood test, X-ray, minor surgery etc., during their treatments. Each of these phases or operations is referred as treatment tasks or tasks. Time taken for each of these treatments varies for each patient, as a result of which the waiting time prediction and the treatment recommendation have become very complicated tasks in the hospitals. This document is a report for the project "PREDICT QUEUE WAIT TIME IN HOSPITAL ENVIORNMENT". The project is an attempt to design and create an UI (User Interface) for applications so that they can be used by numerous different hospitals and the companies where the wait time and crowd is more so, the wait time can be minimized and proper time can be maintained and the wastage of time can be minimized. Appropriate technology management is essential for the continuity of medical care activities especially in critical phases (holidays and nights) during this period, in order to maintain business operations at an acceptable pre-defined level, special technical assistance is essential. Although most of the healthcare services meet only emergency and most of hospital areas are not available, the technology recover can be longer and affecting the regular day working time. Moreover, when a device fails, it should be possible to find a "twin device" within the hospital area and, at this point, the matter should be where it is better getting the twin device for avoiding activity problems on the lender ward.

The aim of this project is to predict Queue wait time in a Hospital environment and to produce wait time, the user can get the exact right time the user going to spend in the Hospital. In other words, the goal of this project is to abstract the In-Time and Out-Time so user can get the specific time given to the Hospital. Thus, access to all available slot present in the Hospital and as per the user convenience the time can be managed. Advancements in technology and in the medical field in order to provide the efficient and better services to the patients keeps on changing to improve the life quality and to meet the life expectations. Hospitals are facing pressure in providing the better services to the patients who were previously unable to get the treatments on time because of the rising demand for hospital resources and the increased patient waiting time in the hospitals. The current patient waiting times are often intolerable and have placed a great stress on the clinical staffs. As a result, health care providers are largely turning into a clinical decision support systems (CDSS) and health information technologies which aid the hospitals in clinical decision making. This project also explores the possibility that a user may wish to control an application from multiple locations regardless of the Hospital that they have access to at that point in time.

II. QUEUE THEORY

Queues are a common occurrence in our daily lives.

Waiting in front of the booth to get a train ticket or a movie ticket, at the door of the toll road, at the bank, the

cashier at the supermarket, and other situations are often encountered occurrences. Queues arise due to the demand for services exceeds the services ability (capacity) or services facilities, so that users of the facility that arrived could not immediately get the service due to the busyness of service. In many cases, additional service facilities may be given to reduce the queue or to prevent queues. However, the cost to provide additional services will lead to a reduction in profits. On the contrary, the frequent occurrence of long queues will result in the loss of customers/clients. In designing queueing systems, we need to aim for a balance between service to customers (short queues implying many servers) and economic considerations (not too many servers).

III. QUEUE COMPONENTS

Arrivals: Every queue problem involves arrival process such as a person, a car, a phone call to be served, and others. This element is often called the input process. Input process includes the source of arrival or commonly called calling population. If the occurrence of arrivals and the offer of service proceed strictly according to schedule, a queue can be avoided. But in practice this does not happen [5]. In most cases the arrivals are a product of external factors. Therefore, the best one can do is to describe the input process in terms of random variables that can represent either the number arriving during a time interval or the time interval between successive arrivals [5]. If customers arrive in groups, their size can be a random variable as well. According to Levin, et al [6], a random variable is a variable whose value can be any amount as a result of the randomized trials. A random variable can be either discrete or continuous. If the random variable only has some possible value, it is a discrete random variable. In the contrary, if the possible value varies in a certain range, it is known as continuous random variables. Typically, the arrival is described by a random distribution of intervals also called Arrival Pattern.

System: The very long queues and too much time to obtain turn services will make customers uncomfortable. The average length of waiting time is dependent upon the rate of services. The emergence of queues, especially depending on the nature of the arrival and service processes, if there is no queue means that there are waiters who are idle or excess of service facility.

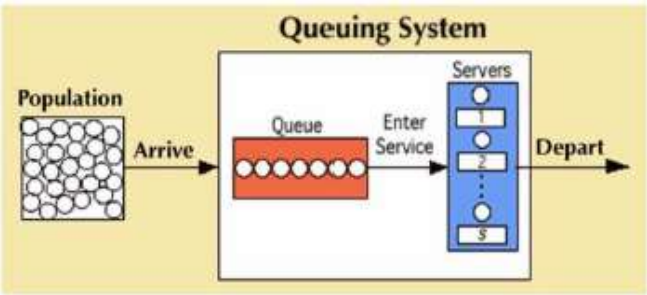


Fig 1:Queuing System

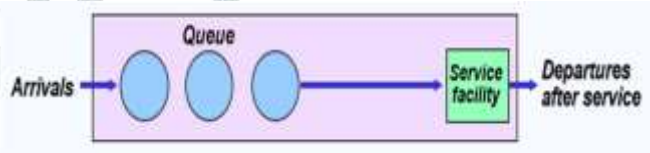
Another important determinant is the queue queuing discipline. Queuing discipline is a decision rule that describes how to serve customer, there are four forms of commonly used queuing disciplines, namely:

1. First Come First Served (FCFS) or First IN First Out (FIFO) Means that the customers who first came (in), is the first served (out).
2. Last Come First Served (LCFS) or Last IN First Out (LIFO) Means that the customers who last came (in), is the first served (out).
3. Service in Random Order (SIRO) means that the customers are served in a random order with no regard to arrival order. That customers who first came (in), is the first served (out).
4. Priority Service (PS) Priority Service (PS) means the service priority given to the customer that has a higher priority than customers who have a lower priority, although the latter is possibly the earliest to arrive in the waiting line. Such an event may be caused by several things, such as someone who is in a state of more severe disease compared with others in an ER.

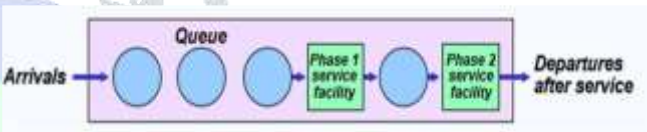
IV. QUEUE MODELS

There are 4 basic queuing models which are commonly occur in the queuing system:

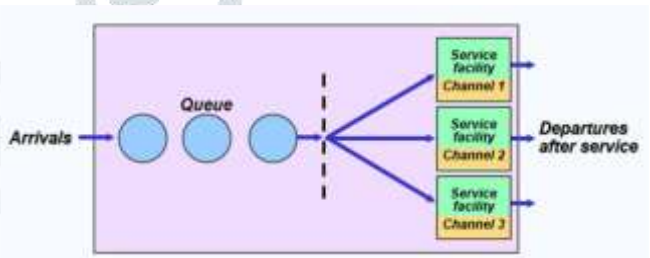
1. Single Chanel - Single Phase



2. Single Chanel - Multi Phase



3. Multi Chanel - Single Phase



4. Multi Chanel - Multi Phase

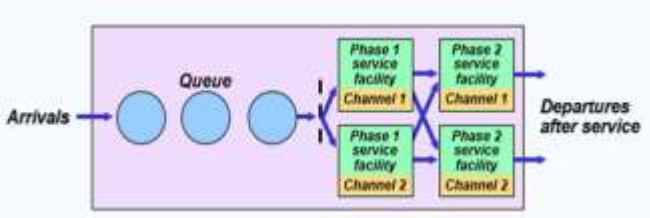


Fig 2:Queue Model

Currently applied queue and processes management systems could be the cause of slow and long service in the health facilities. So, it is important for the health facilities to look seriously and analysed the process flow of its service if it wants to improve the service waiting time. Starting from the stage before registration to discharge. the Health facilities need to identify the steps that need to be improved in order to reduce and even eliminate the slow and long impression. The use of information system,

besides useful to quicken the delivery of information, information systems in the form of patient medical records and patient registration software / queue applications can make the process of service performed simultaneously and not repetitive. For example, when a patient has registered, medical record data can simultaneously be received at the clinic, and even proceed to the pharmacy or administration section when the patient had been served by the doctor. Repeated registration recording, manual/paper-based prescription or medical records is not required. with such a system, the whole process in health facilities can be more effective and safer. Overall waiting times within each point of the service stages can be reduced significantly. Moreover, by including queue monitoring system in patient registration software, after the patient registered, he got the queue number and he can see directly which number is being served and how many patients left before he receives medical service. By knowing that information, the slow and long impression can be reduced. If the patient can predict the time for his service, the patient could do something else or go somewhere else while waiting.

V. PROPOSED METHODOLOGY

It will be good if the patient can receive the effective treatment recommendation and able to know in advance the total waiting time, he/she must spend in the hospital. To overcome the above problems, Patient Treatment Time Prediction (PTTP) process is proposed which calculates the patient waiting time for each of the treatments. Based on the waiting time calculated by the PTTP, a system is developed which is named as Hospital Queuing-Recommendation (HQR) whose task is to recommend an efficient treatment plan for each of the patients in the queue, thereby minimizing the overall

waiting time of the patient. The problems formulation in this research is on how to make a queue system controlled by a computer program so that it reduces the work load of health facilities employee. And, by the existence of computerized queuing system the queues in health facilities could run smoothly without any problems. The objective of this study was to design a queue system at a health facility in global nature and enable to be used in other queue case. There are two kinds of patients namely, Emergency patients and Non-Emergency patients, where the emergency patients are given priority over the non-emergency patients. As a result, there exist two scenarios:

1. When there are no emergency patients registered for the treatments, then PTTP process considers only the non-emergency patients and calculates the waiting time for each of them based on the age and gender criteria. Based on the calculated waiting time, HQR system prepares the treatment plan recommendation for each of the non-emergency patients such that every patient completes their treatments within the shorter time.
2. When there are emergency patients along with non-emergency patients, then PTTP calculates waiting time for both emergency and nonemergency patients separately, and then HQR system provides treatment plan recommendations for each of these patients. If there are p(n) patients and patient p1 required 3 steps for the completion of the treatment then the total time for the patient p1 would be the sum of each steps i.e. total time = T(s1) + T(s2) + T(s3). Our algorithm will predict the time for each individual steps i.e. T(s1), T(s2) ....., T(sN) in such a way that the waiting time for patient would be minimal at each step.

Treatment Records

Patient No	Gender	Age	Task Name	Dept.Name	Doctor Name	Time Elapsed
001	Male	17	Checkup	Surgery	Dr Hamza	5 min
001	Male	17	Payment	Cashier	NULL	2 min
001	Male	17	CT Scan	CT-7	Dr Alex	20 min
001	Male	17	M R Scan	MR-5	Dr Faddy	15 min
001	Male	177	Medicine	Pharmacy	NULL	3 min

Fig 3:Treatment Record

In above table, Time Required for Patent 001 is 5 min to complete all the tasks or treatments. This time will be addressed to the Patient 002, initially his task will be of check-up so he Patient 002 gets a wait time of 5 min for check-up after that wait time depends on the task which will be assigned by doctor.

Model for Predicting Wait Time In Multi Stage:

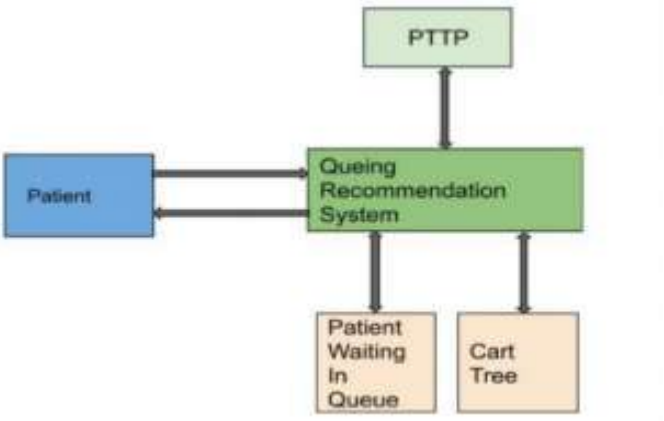


Fig 4:Model for Predicting Wait Time

Method to Predict wait time in a hospital i.e. (intime+ out time) and Communicate wait time:

We will do it by training the PTTP model by Machine Learning techniques: -

1. To train the patient time consumption model for each treatment task, we choose the same features of these data, such as the patient information (patient card number, gender, age, etc.), the treatment task information (task name, department name, doctor name, etc.), and the time information (start time and end time). Other feature subspaces of the treatment data are not chosen because they are not useful for the PTTP algorithm, such as patient name, telephone number, and address.
2. To train the PTTP model, various important features of the data should be calculated, such as the patient time consumption of each treatment

record, day of week for the treatment time, and the time range of treatment time.

3. After calculating new feature variables of treatment data, the error and noisy data need to be removed the patient treatment time consumption based on different patient tasks and time characteristics must first be calculated. The time consumption of each treatment task might not lie in same range, which varies according to the content of tasks and various circumstances, different periods, and different conditions of patients. So, we use the RF algorithm to train patient treatment time consumption based on both patient and time characteristics and then build the PTTP model.
4. After training the PTTP model for each treatment task using historical hospital treatment data, a PTTP-based hospital queue recommendation system is developed. An efficient and convenient treatment plan is created and recommended to each patient to achieve.
5. After completing the successful training of PTTP model by machine learning techniques, our model is ready to predict the both in-time and out-time of the patient.

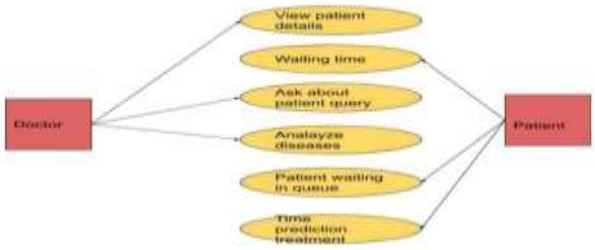


Fig 5:Chart

This follows the development of a hospital glowing recommendation system which could expect what the disease is in response to the symptoms diagnosed and the patient gets an efficient and a convenience treatment plan. Once the patient has completed the treatment in a particular doctor as a particular Hospital review or a feedback is taken and then used for the prediction of the best doctor with respect to certain aspects like the cost of treatment, the procedures done, the effectiveness of the treatment suggested, the waiting time taken, etc. This will in future anywhere any human who is suffering from any disease to search for the best doctor in a hospital nearby based on the symptoms using an Internet connection from his home. After conducting extensive bouts of experimentation and verifying the results of the application so that the patient treatment time algorithm and the Hospital queuing recommendation system have achieved great physician with respect to its applicability and its performance has been deemed efficient. The training data set was made by the collection and screening of large data from more than a few hospitals and laboratories and the algorithms were applied to the large data to delete the outliers. The big data techniques were applied to predict the disease based on the symptoms and the slots were booked to respective doctor with respective to the predicted time. After the doctor's check-up, based on the prescription the laboratory tests slots were booked with respective to the predicted time. At the end a feedback form was given to the patient to get the feedback, based on that feedback the best doctor was suggested to the new patient.

VI. QUEUE SYSTEM DESIGN:

The main problem solved through this queue system is the queue number retrieval by the patient and the waiting time of the queue that was initially unpredictable becomes known to the patient. The queue system will be implemented in health facility which has one or more departments (excluding the ER department) and more than one type of services, therefore, multi-channel - multi-phase queue model with First Come First Served algorithm is used. This queue system consists of Web application, pc and screen to display queuing sequences, printer to print the queue number and speakers to call queue numbers.

Fig 6:Layout

VII. NEXT PLAN OF ACTION

1. Gathering input data that is derived from different procedures, tasks, and strategies: medium sized Hospital has the capacity of 8000 to 12000 number of patients per day depending on certain statistics and figures 120000 to 2 lacs are the number of numbers of treatment records that is input in hospital in hospital database. These inputs are collected from many different procedures conducted in a medical institution like medical examination of a patient, registration of admission, Drug Delivery, inspection, payment of bills and many other procedures. Different formats are used to store the input data for different treatment procedures.
2. Choosing the data dimensions that are identical: the input data generated inside a hospital for treatment procedures from various tasks are created in different contents and different formats in addition to the different dimensions. We must decide on similar features of the input data in order to train the model for the time utilisation of a patient for each procedure conducted. The subject or patient information can be one such feature. The information can be a patient's card number, gender, age of the patient, etc. The information related to the treatment procedure and the time taken can be another feature. There are more innovative attributes of the treatment data which will not be taken since they are useless to the PTTP algorithm. These include data such as name of the patient, telephone number or address.

VII. CONCLUSION AND FUTURE RESEARCH

The problems in queue system in health facilities can be solved if the queueing theory is understood and implemented. The health facilities commonly have some department and various services, so the queueing model that match those criteria is multi-channel multi-phase, therefore, IT based-the queuing system should be developed also based on multichannel multi-phase queueing model. In order to make it easier to be implemented, the queue system will be developed in form of web application. To support the future research, the queue application should be developed as a module that can be integrated with other module which later become integrated health facilities information system consist of (1) registration/queue, (2) patient medical records, (3) polyclinic, (4) inpatient, (5) outpatient, (6) emergency room, (7) pharmacy, (8) inventory, and (9) automatic health facility reports. By using this integrated health facilities information system, the service effectiveness and efficiency will be improved and patients' satisfaction can be increased.

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