HOSPITAL SERVICE QUEUE MANAGEMENT SYSTEM WITH WIRELESS APPROACH

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Abstract. This paper presents a proposed alternative system for queuing management that could reduce inconvenience to the public. The motivation of this system is depicted from an observation on the people queuing for services in the hospitals and the government offices without committing to the estimated time for their demand. Waiting for the service is counterproductive which consumes an unacceptable amount of productive time for the patients. We develop the system to manage the queue without physically lining up and allow people to monitor their queue status by their wireless handheld devices. The project accomplishes its objective as a tool to manage the hospital queue online where customers, patients and stakeholder can access theirs queues remotely over the Internet through a web application. The results benefit to both stakeholder to manage their time for other desire activities and hospitals in utilizing its spacious area for other business proposes.

Keywords: Hospital queuing management system, web application.

1 Introduction

The innovation of technologies could bring support to the quality of life for human in various aspects and objectives. However, in order to apply and implement technology system to be used requires the costly investment for itself. This constraint leads to the inescapable archaic management methods, and the systems still coexist alongside the advances in procedures. One of the unavoidable significances is the hospital service for the people, especially among the undeveloped country and developing country. The public hospitals likely support the poor and middle classes which have to patronize the public services in the state hospitals.

A growing population base will continue having a pressure to the existing hospital facilities. With the cycle of limited facilities, it leads to the coupled staffing shortages which will guarantee that long queues to remain synonymous anytime visiting a hospital and other public service facilities. The people must take a queue as long as they need the services. Whether the problem is caused by staff shortages, equipment shortages, or the hospital capacity is not sufficient for the population area they serve. Long queues are an unwanted and unnecessary burden to the public as well as the hospital staffs. Long queues are then associated with a negative image of the hospital experience, but most people can't avoid to be under this present system.

For this project, we propose the system with the main objective as to create a visual queue for hospital online where people can access and reserve their queue wirelessly over the Internet. The system allows people to monitor their queuing status from the web service application. This beneficial system is designed to offer the options for people who are waiting for the service; they can go anywhere while they are in the queue rather than standing and presenting themselves in front of the service area.

2 Literature Review

The traditional queuing management methods mostly used in the hospital are queue card and smart queue as described it featured by figure 1.When using queue card system, the people in the queue are assigned by numbers according to the arrival order. This method allows the patients to be able to manage their time based on an estimation of the time available until their number is called. Venturing outside of the immediate area is a constant gamble. The queue number may guarantee service according to the number priorities; however, a delay in returning may still result in the loss of a queue position.
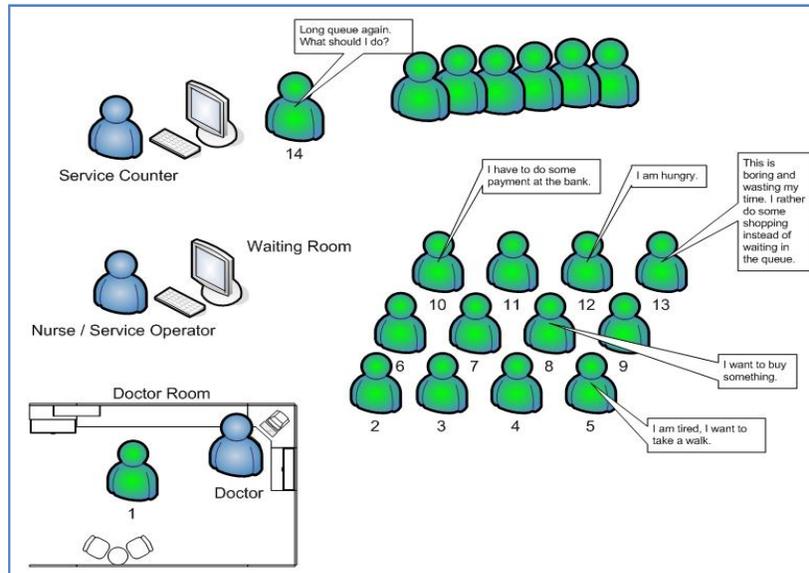

Fig. 1. Typical state hospital queue management system

Most of the private hospitals provide a smart queue system as well as helpdesks and counter services for their customers. The smart queue system provides automatic queue numbers along with automatic voice calling and LED display panels on a progressive basis. However, this system still requires patients to congregate in the immediate area to monitor the progress of queue numbers being serviced. This service

only eliminates the need to stand in an organized line, but does not address a more productive method for time utilization

Based on a survey, people waiting in a queue get a service from public hospitals in rural area in Thailand reveal that they are compelled to endure the endless waits. They lined up at the service counter. Any abandonment results in their requirement to return to the back of the line and an even longer wait. With such a long queue and waiting period, it represents a considerable amount of time wasted for the people involved. Any desire to venture outside the immediate area is outweighed by the uncertainty of not having information regarding the progress of the queue. They simply cannot miss their position due to a lack of information. This problem motivated us to develop a method to manage the reserved queue to alleviate on minimizing the number of people in the physical queue

3 Service Queue Management System with Wireless Approach

3.1 System Boundary and Architecture

The new approach of the hospital queue management system will provide stakeholder with tools to manage their queue status wirelessly [1]. The system would allow them to know what is going on with the queue wherever they go. As can be seen in the figure 2 a new comer arrives at the service counter before booking into the hospital queue. With their wireless devices, the queue status can be accessed through the Internet, and it provides information to everyone in the queue.
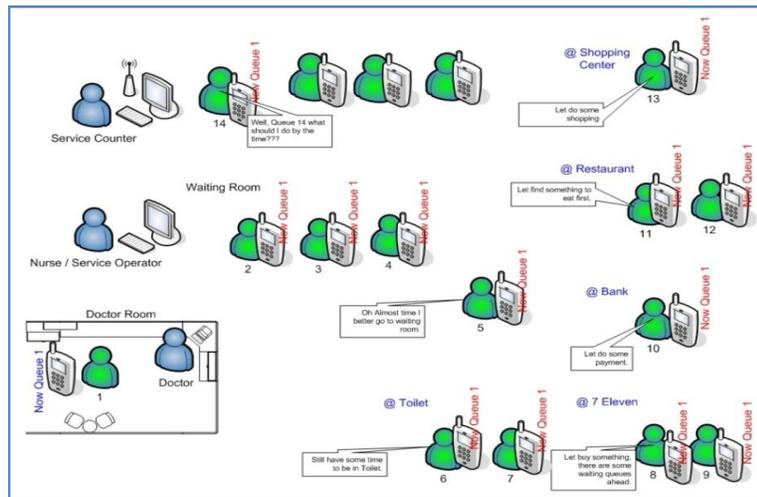

Fig. 2. Existing Hospital service queue management system

The proposed system, the boundary and its functionality are described in a form of UML concepts [1,2] shown in figure 3. The system's functionality is demonstrated and explained as the role of four actors and seven use cases as following:

Actors role;
- **System Admin***: represents an administrator who grants access to all system features; the role is to register a new hospital and queue administration to the system.
- **Queue Admin**: represents a hospital queue administrator, the role is to create queues and operators to the system.
- **Queue Operator**: represents a person who takes care of each queue. The role is to register queue client to the system and to manage all activities in the queue.
- **Queue Client**; represents the person who requires hospital service and is seated in the queue. The role is to view the queue status in order to know when to be in the service.
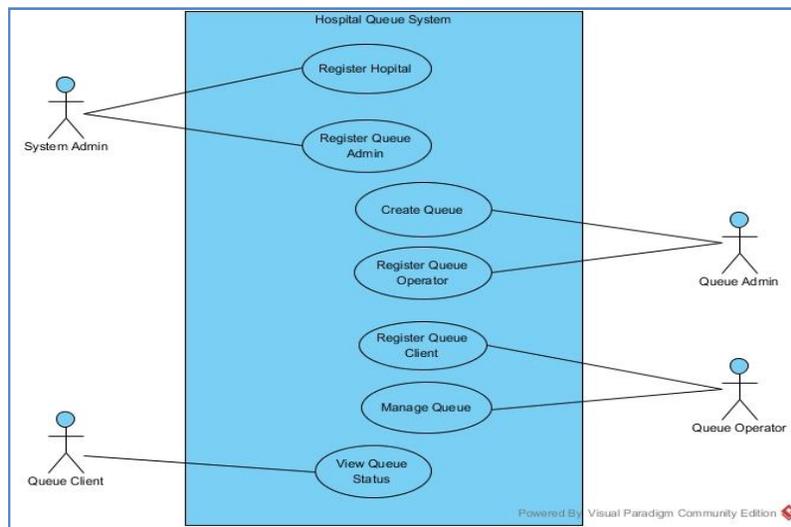

Fig. 2. Hospital Queue System Use Case Diagram

Use case role;
- **Register Hospital**: Describes a behavior for the system administration to register hospital details into the hospital queue system.
- **Register Queue Admin**: describes a behavior that a queue administration is created by the system admin.
- **Create Queue**: Describes a queue that is created by queue administration.
- **Register Queue Operator**: Describes a behavior that a queue operator is created by the queue administration.

- **Manage Queue:** Describes how the queue operator manages all activities that happen in a queue, including the insertion of a client to the queue, put queued client into a service and end the client from the queue after the service is complete.
- **View Queue Status**: Describes a behavior where a queue client can check or view their queue status during the queue process.
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3.2 Database and Development Tools

We consider using Java programming run on Java EE environment [3], Glassfish as its web server and running web service on WSDL (Web Services Description Language) model running with XML to view and exchange data. A system based on Java technology could be strong in term of security and great in term of performance and implement with RESTful [4] architecture. The set of tools is an advantage of ease to access and deployment.

Database is created by using PHPMyAdmin [5] which is MySQL [6] management program. It comes together with XAMP [7]. The entities and relationships system is deployed with relational database [8] principle which consists of five tables. Qbusiness table stores the entity of the hospital that is registered to the hospital queue system. Quser table stores the entity of user who works with the system. Qqueue table stores the entity of a queue which is created by queue administration. Qtran table stores the entity of a queue transaction which is generated through queuing process. Customer table stores the entity of a queue client or a patient who requires hospital services and seating in the queue.

3.3   Queuing Management Mechanism

In this project "First Come, First Serve" concept and queuing theory with Little's law [9,10]is deployed as the system discipline to manage service queue. Given λ is the average number of items arriving per unit time; W is average waiting time per for an item, and L is an average number of items in the queuing system, so **L = λ/W.**

The Arrival Rate **(λ)** is formulated by a division of Total arrival (N) by Total Time(T) as **λ = N/T.** This means that at the time interval T the system has been observed, the number of arrival N entering to the system queue.

Finding individual waiting time : In order to find the time remaining or waiting time for an individual in the queue, we need to know the average waiting time W of the system at the period time T by being calculated from equation (1).

$$W = \frac{1}{N}\sum_{i=1}^{N} Wi \qquad\qquad (1)$$

To calculate the waiting time for the Nth queue number to be in service, the average waiting time needs to be calculated onward to get the most likely average time. For instance, the queue may have an average L customers waiting in the queue

with arrival rate λ, so calculating the average waiting time is $W = L / \lambda$. Therefore, the expected waiting time for the Nth queue to reach the service is

$$WN = \sum_{i=1}^{N} Wi \qquad (2)$$

According to the equation(2), an individual waiting time could be rewritten as the average waiting time multiply by the number of individual a queue number approximately. As of continuous system, the estimate time waiting could be denoted as the equation (3).

$$W(n, m) = mW_n \qquad (3)$$

Where **m** is the queue number of an individual queue and **n** is the number of queues included in average, an estimated waiting time of an individual, $W_{(n,m)}$ could be suggested to the customer of the queue as the multiplication of queue number m with the average waiting time W_n.

4   System Prototype Implementation

The proposed hospital queue system is required to run over the Internet or intranet; therefore, the stakeholder, system administrative users and patients can use their smart phones and Internet access devices to view their queue status. The system prototype is demonstrated by testing with a set of tools and equipment as described below:

- Locally testing with XAMP

The web server needs to be set up and tested on Windows environment and running on XAMP v3.2.1 [7], which is a bundle package of Apache, MySQL and PHP [11,12]. However, the system cannot fully operate locally since the customer/client/patient must be able to view a queue status over their wireless device. Therefore, the system has to be online to serve this requirement.

- Online hosqueue.com

To take the system online, a domain name needs to be registered. Also, it has been named as hosqueue.com. The system domain is also hosted with one of a domain hosting providers which gives the system space and requires server environment for the system to run.

The system has been done on top of the previous code taken from the open source software called Complain Management System written by Tousif Khan [13]. The system is built on top of pre-coding and structure with a new database design and new business processing. The system is built on PHP [11], [14] and Java Script [4], coding example is shown in the following page. The code represents part of PHP requesting queuery to the database before converting into JSON data format which performs RESTful web service. As it can be seen in the code, one important requesting element is AvgTime (Average Time). The system allows the queue admin to modify the number of samples of individual waiting time as a set of average time waiting. AvgTime is then to be used to calculate time remaining for the next remaining queue.

```php
  $sql = "SELECT
qtran.QueueID,queueno,CustID,arrive,tstatus,qqueue.AvgTim
e FROM ".$dbname.".qtran INNER JOIN ".$dbname.".qqueue ON
qtran.QueueID = qqueue.QueueID WHERE qtran.QueueID
='".$qid."'";
      $result=mysql_query($sql); $rows = array();
      while($r = mysql_fetch_assoc($result)) {
$rows['Queue'][] = $r; }
      printjson_encode($rows);
```

[Example of PHP script on data conversion by using json_encode function yields requesting queue data output into JSON data format.]

The main operation is on queue management system on PHP demonstration. When the customer/client/patient queue viewer is mainly on Android [3], [15], [16] application, coding example is shown below. This part of the code allows the application to retrieve JSON data format from the PHP web service. AvgTime abruptly calculates time remaining equivalent to the sequential order of the patient queue number. This part of the system allows the user to access data over their wireless device.

```java
public void ListDrawer() {
  try{JSONObjectjsonResponse =
                  newJSONObject(jsonResult);
      JSONArrayjsonMainNode =
                  jsonResponse.optJSONArray("Queue");
      rowQueue.clear();
      for (inti = 0; i<jsonMainNode.length(); i++) {
  JSONObjectjsonChildNode =
                  jsonMainNode.getJSONObject(i);
      columnQueue.set(0,jsonChildNode.optString("QueueID"));
      columnQueue.set(1,jsonChildNode.optString("queueno"));
      columnQueue.set(2,jsonChildNode.optString("CustID"));
      columnQueue.set(3,jsonChildNode.optString("arrive"));
      columnQueue.set(4,jsonChildNode.optString("tstatus"));
      columnQueue.set(5,jsonChildNode.optString("AvgTime"));
      columnQueue.set(6,String.valueOf(Integer.valueOf(
            jsonChildNode.optString("AvgTime"))*60*(i+1)));
      columnQueue.set(7,String.valueOf(Integer.valueOf(
            jsonChildNode.optString("AvgTime"))*60*(i+1)));
      rowQueue.add(new ArrayList<String>(columnQueue));
      }
  } catch (JSONException e) { ... }}
```

[Example of Android programming function calledListDrawer, which retrieves JSON data format and displays on Android client application.]

- **Installation Client Application with Android**

An Installation client program for Android application hosqueue.com is stored in an APK file after its compilation. The customer can download the file and install it to an android device. The program requires running on Android 4.0.3 (Ice Cream Sandwich) and above.
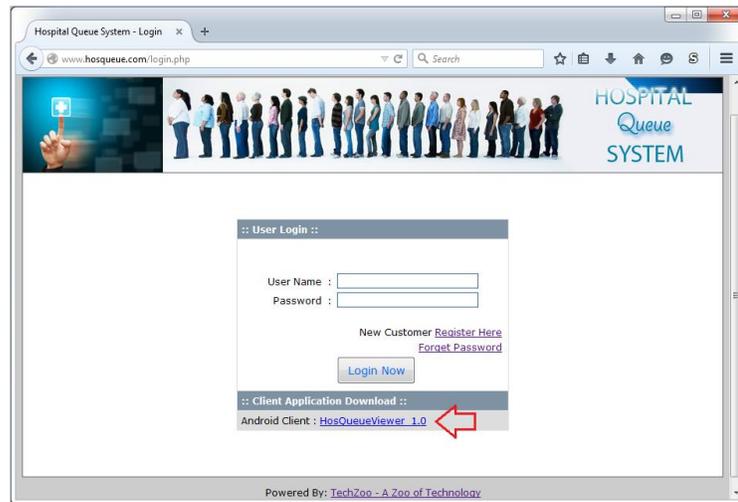

Fig. 4. Available download of hospital queue viewer 1.0

The system function will display all the queue and find queue by ID as shown in figure 5.

- **Display All Queue**: The Display All Queue button leads to a view by queue selected screen where the customer can view the queue by choosing a particular queue that they want to view. Therefore, the customer is required to know which queue to look for.
- **Find Queue by ID**: The Find Queue by ID helps the customer in searching the queue in case that the customer does not know which queue it is. However, the customer is still required to know their customer ID to be used as a finding key to the queue.
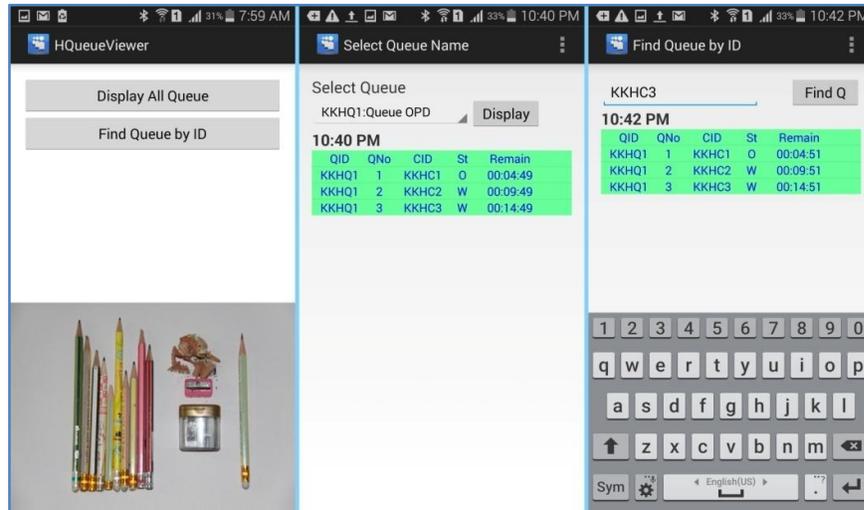
Fig.5. Queue display by searching customer ID

The queue displays the queue number, customer ID., queue status, and estimated time of service. This can help the customer go anywhere nearby or do other activities while still knowing the queue status.

5   Conclusion

Hospital Service Queue System is a project to eliminate the traditional physical queue and replace it with a convenient management. This project is designed to help the public who suffers from long queues in hospitals, especially the public hospitals. The main system functionalities which are constructed and implemented online are ready for hospital queue services; hence, the customer/patient/client can view a queue status over their wireless.

The contribution of this system does not only serve the people requesting the service in hospital but also utilize their time to do other activities. Also, the advantage of using open source it could benefit to community as a whole. Not only one hospital can benefit with the current system design and setting, but multiple hospitals can be served at the same time. An individual hospital can manage its own queues with a given power user as a queue administration. With this design, a cost sharing arrangement is possible amongst hospitals without having any budget to spend for the extra development.

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