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A Smart Decision based Efficient Clinician Scheduling System for Avoiding Patient Waiting Time

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ABSTRACT: Healthcare Management is the major concern in now-a-days to care about and the waiting time for every hospitals or clinics are growing day by day. For avoiding this patient's waiting time problem, many schemes are introduced by hospitals, but all are in some sort of arrangements to manage. However, a permanent solution is required to solve this issue and makes the patient to calm and relax while coming for treatment. The current health care landscape desired efficiency and patient satisfaction for optimal performance. The outpatient of most clinics in developing countries is faced with plethora of issues. In this paper, a new Decision-Support environment is formed to help patients to be relaxed while coming to clinic without any hardness to consult doctor for their respective needs. The past implementations have grown how to model a simulation dependent on process mining strategies. In any case, applying this technique for out-patient forms clearly, specifically therapeutic planning, is complex, such as: (a) the gathered information from automatic health record framework requires a progression of procedures to gain reproduction parameters from the raw-information and (b) regardless of whether the inferred reenactment model completely mirrors the truth, there is no deliberate way to deal with determining successful upgrades for recreation investigation, that is trial situations. This paper focuses on developing a system to improve upon the efficiency and quality of delivering a web based appointment system to reduce waiting time. To rectify these difficulties, this proposed system introduces a Novel Decision Support System (NDSS) for a clinician's schedule analysis via experimental setup. In the proposed system, information driven prototypical model is built dependent on process discovery, patient arrival rate analysis, and service time analysis. Likewise, a progression of steps to infer the ideal improvement technique from the prototypical investigation is remembered for the system. To exhibit the helpfulness of our methodology, we present the contextual analysis results with genuine information in an emergency situation over clinical environments.

KEYWORDS: Healthcare, Patient, Appointment, Scheduling, Clinician Appointment Scheduling, Novel Decision Support System, NDSS.

I. INTRODUCTION

I In today's machinery world, health care sector is the pivot and integral part of human lives. Thus, any issue committed in the hospital services might leads to defect or termination of life. Recently, information and Communication has been used extensively to improve the various operations and services in the field of the health care service. Patient appointment with the Doctor is one of the clinical services that have been automated. Healthcare

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providers are motivated to reduce operation cost while improving the quality of service. This has given rise to preventive medicine in order to avoid disease, lessening the demand for emergency department and hospital stays for sick people. The importance of Patient Scheduling cannot be underestimated in the health care delivery landscape. Patient scheduling is a complex process that performs a crucial role in health care. In outpatient processes, long waiting times for consultation for patients can be considered as critical problems [1][3]. The longer patients have to wait before their consultation can take place, the less satisfied they are, which may lead to decreasing profits [4][15][16]. A confounding factor is that there are significant differences with respect to quality delivery and efficiency among clinicians. In order to handle this problem, it seems worthwhile to consider how the personal appointment schedules of clinicians can be optimized as to improve the overall efficiency of patient management.

Unfortunately, it still has certain challenges to straight-forwardly apply this method for outpatient processes, in particular, medical scheduling.

(a) The collected data from Electronic-Health-Record (EHR) system requires a series of processes to acquire prototypical parameters from the raw information. Three main elements for building a healthcare prototypical model such as: a process of medical activities, service times and arrival rates. Out of them, it is hard to find out actual values of the service times and arrival rates from EHR data due to the following reasons:

- **Service Times:** EHR systems, which typically, only record completion time of clinical activities.
- **Arrival Rates:** Patients visit a hospital with a scheduled appointment; thus, the reservation system needs to be considered.

(b) Even if the derived prototypical model fully reflects the reality, there is no systematic approach to deriving effective improvements that is empirical scenarios. The next step of building a prototypical model is to identify all the possible alternatives and determine the best option for the optimal decision making with simulation analysis.

However, the existing methods presented in this regard are all heuristic oriented and unstructured approaches. Therefore, a bridge that connects the prototypical model analysis and useful scenarios is still missing. To overcome these challenges, this paper proposes a Novel Decision Support System (NDSS) for a clinician's schedule using systematic analysis.

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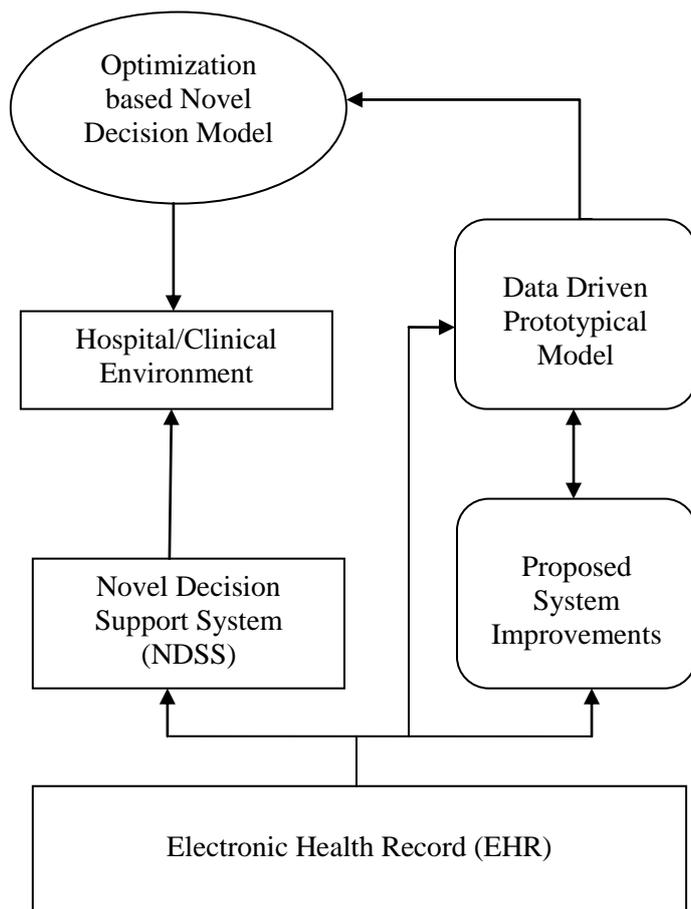


Fig.1 NDSS Work Flow Design

Patient scheduling performs several functions, from allocating resources to patients in need of exams and allocation of surgery rooms to on-demand appointment scheduling with Family Doctors working at Primary Care clinics. A good appointment scheduling system encourages patient and physician satisfaction, and as such, is an important component of healthcare [1][2]. The efficiency of health care delivery hinged solely on the effectiveness of the Patient scheduling system. It reduces medical error among practitioner and also reduces the number of unsatisfied patient. Appointment systems have been extensively used to reduce patient waiting times and waiting-room congestion [2][3][4]. Such systems have the potential to increase access to medical resources while reducing cost, as well as staff and patient dissatisfaction derived from unmet schedule constraints. The main aim of optimal patient scheduling is to determine an appointment technique for which a particular measure of performance is optimized under uncertain conditions [2]. Appointment scheduling system is a system for planning of appointments between resources such as patients, facilities and providers. It is used in order to minimize waiting times, prioritize appointments and optimize the utilization of resources.

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II. SYSTEM ANALYSIS

A. Existing System Summary

In past system of patient appointment system to meet the doctor is so complex, especially the process of scheduling maintenance is so critical. Scheduling can be described as the process of assigning jobs to resources for some duration. Scheduling problems are ubiquitous, ranging from computer systems and networks, to production factories and patient appointments. Many of such problems are either solved by manual operation or using heuristics specifically designed to the context [11][12][13]. There are three different types of scheduling processes are handled in past such as:

Single Batch Process: In this Appointment scheduling process, decisions are delayed until after receiving all appointment requests for a given period. This model is commonly used in surgery starting times, and allows scheduling with complete information, so that a perfect or near perfect solution can be found through discrete optimization or heuristic methods.

Unit Process Appointments: In this appointment scheduling model, the process is assumed to come one at a time and are scheduled at the time of the request arrival. Through this process, a perfect solution will unlikely be found, but may be approximated if the distribution of appointment request types is learned.

Periodic Process Appointment: requests are kept in a buffer of fixed size and are scheduled once the buffer is full. This allows a better approximation to the optimal solution by considering optimal or near optimal solutions at each period.

All these process of scheduling is complex and the process is vague to maintain and patients feel more stress to meet the clinician in proper time. So, for this process a new approach is designed to solve the existing issues. The solution found on that time is Online Scheduling process and waiting time elimination method.

Online Appointment Scheduling System: Online appointment scheduling system is a system through which a user or guest or simply, patients can access the website of the doctor, and through the online software, patients can easily make their appointments. In addition to that, patients can also provide additional information to the doctor, making the doctor aware of their situation and giving the doctor time to prepare the necessary information for when the patient's arrives. An online scheduling system allows individuals to conveniently and securely book their appointments online. Compared to the usual queuing method, the web-based appointment system could significantly increase patient's satisfaction with registration and reduce total waiting time effectively [10].

Waiting Time: Waiting time refers to a period of time which a patient must wait in order for a specific action to take place, after that action is triggered or requested and it is defined as "the length of time from when the patient entered the outpatient clinic to the time the patient actually received his or her prescription. It is also described as the total time expended by a patient from registration until consultation with a doctor [11][16][17].

III. RELATED WORKS

In the year of 2015, the authors Thomas, Kaitlyn [21] proposed a paper titled "A Decision Support Tool for Appointment Scheduling to Reduce Patient No-Show Rate in an Outpatient Psychiatric Clinic [21]", in that they developed a decision support system Tool for Appointment Scheduling to Reduce Patient No-Show Rate in an Outpatient.

In the year of 2015, the authors "S. Sri Gowthem and K.P. Kaliyamurthie [5]" proposed a paper titled "Smart Appointment Reservation System [5]", in that they proposed a smart appointment reservation system. The proposed system helps in managing appointments and also provides platform for patient to cancel or reschedule appointment by integrating distributed clinical systems into a set of consistent and convenient services accessible via a web browser.

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In the year of 2014, the authors "S. B. Choudhari¹, Chaitanya Kusurkar, Rucha Sonje, Parag Mahajan, Joanna Vaz [20]" proposed a paper titled "Android Application for Doctor's Appointment [20]", in that they proposed a mobile application for booking appointment using Android. The authors developed a system that will ease the process of booking appointment of the doctor. The patient will book the appointment through his/her mobile phone. The doctor, at the other end could determine the number of patients he has to attend whole day.

In the year of 2017, the authors "Peng Zhao, Illhoi Yoo, Jaie Lavoie, Beau James Lavoie and Eduardo Simoes [7]" proposed a paper titled "Web-Based Medical Appointment Systems: A Systematic Review [7]", in that they proposes an online patient appointment scheduling system based on the Web Services architecture. The analysis and implementation results show that the Web Services architecture provides an ideal design paradigm for the development of integrated health care information system in the primary care setting.

In the year of 2012, the authors "Chutisant Kerdvibulvech and Nwe Ni Win [23]" proposed a paper titled "The Dentist Online Reservation System Design and Implementation Web Based Application and Database Management System [23]", in that they proposed a dentist online Reservation System. The aim of the proposed system is to save the time and effort of the users in safe and convenient ways. It enables patients to book and check their appointment schedule. Administrator to maintain the database online easily. It enables the administrator to check the patient's requests, manage the appointment schedule, and manage the patient's information.

In the year of 2017, the authors "Ahmed Baita Garko¹ and Usman Mahmud [14]" proposed a paper titled "Design And Implementation Of Outpatient Management System [14]", in that they proposed a framework for heuristic dynamic policies for scheduling patient appointments, taking into account the fact that patients may cancel or not show up for their appointments.

In the year of 2019, the authors "Mohd Helmy, Abd Wahab, Norlida Hassan¹zaidah Wali Mohd¹, Hafizul Fahri Hanafi [12]" proposed a paper titled "Web Based Intelligent Appointment System [12]", in that they [12] developed a web-based appointment system by integrating with Intelligent System techniques. The system was designed to manage appointment and time reserved between students and Lecturer for any academic-related activities such as discussion and weekly meeting with lecturers. The main focus of the prototype is to manage appointment and calendar updating.

In the year of 2011, the author "Wen-Ya Wang Diwakar Gupta [26]" proposed a paper titled "Appointment Systems with Patient Preferences [26]". The authors developed a framework for the appointment systems that automatically update patients' preferences to improve booking decisions.

A. Proposed System Summary

The proposed Novel Decision Support System (NDSS) for the optimized medical scheduling is composed of four phases: data preparation, process mining analysis, simulation modeling and evaluation, and experiments & decision support. The following figure Fig.2 represents the overview of the proposed framework. First, an appropriate format of data, i.e., an event log, is collected from EHR system's log data of the hospital and preprocessed for effective data analysis in the data preparation phase. After that, three kinds of process mining analysis are performed to derive the inputs for creating a simulation model: process discovery, arrival rate analysis, and service time analysis. Based on these results, a simulation model is constructed, and then the model is evaluated to validate whether the model reflects the behaviors observed from the data (i.e., As-Is analysis). Here, a couple of Key Performance Indicators (KPIs) are employed. Lastly, in the experiments & decision support phase, improvement alternatives are investigated by performing further data analysis. To this end, best practices for business process redesign [16][17][19] are utilized as candidates for process improvement. Then, several scenario-based simulation analyses are performed to identify the optimal redesign method.

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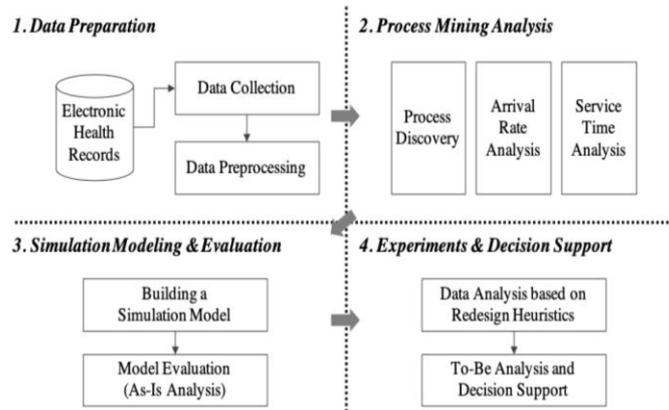


Fig.2 The proposed NDSS Design for medical scheduling

The following figure Fig.3 illustrates the System Architectural overall view of the proposed system.

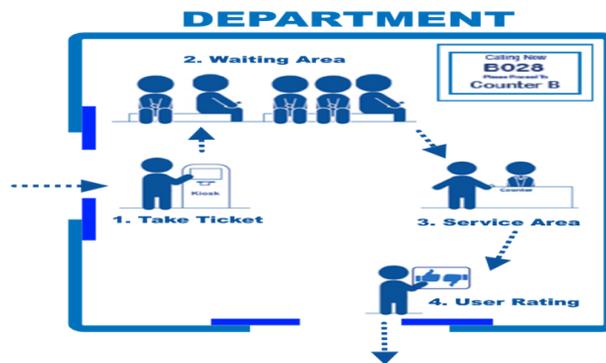


Fig.3 System Architecture

IV. RESULTS AND DISCUSSION

The following summary illustrates the implementation oriented details and the overall view of the proposed system. The following figure Fig.4 illustrates the Queuing System Token Generation System.



Fig.4 Queuing Token Generation

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The following figure Fig.5 illustrates the Ticket generation and Issuing System view of the proposed system.



Fig.5 Ticket Generation and Issuing Port

The following figure Fig.6 illustrates the Queue Waiting Status and SMS view of the proposed system.



Fig.6 Queue Waiting Status View a Mobile Via QR-Scan

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V. CONCLUSION AND FUTURE SCOPE

In this proposed system, we suggested a NDSS framework for optimizing clinician medical scheduling using discrete event simulation approach, which is constructed based on three process mining analysis including process discovery, arrival rate analysis, and service time analysis. Furthermore, it covered how to derive effective improvement methods to decrease waiting time for consultation. In the case study, we applied the real-world data to the proposed framework. Also, we performed the four scenario-based experiments using the simulation model for the personalized care scheduling. As a result, we showed that not only two cases which need additional costs have a significant effect on the waiting time, but also the changes of reservation systems which do not require more costs decreased the waiting time.

As we stated in summary, we plan to work on NDSS approach for medical scheduling. Also, we will improve our framework to make it more automated. More case studies should be performed to validate our approach.

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