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# Enhancing outpatient clinics management software by reducing patients' waiting time



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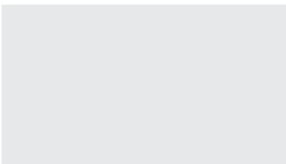
## KEYWORDS

Patient flow;  
Outpatient clinics;  
Waiting time;  
Outpatient  
Management Software  
(OMS);  
Quality of service;  
Health care

**Summary** The Kingdom of Saudi Arabia (KSA) gives great attention to improving the quality of services provided by health care sectors including outpatient clinics. One of the main drawbacks in outpatient clinics is long waiting time for patients—which affects the level of patient satisfaction and the quality of services. This article addresses this problem by studying the Outpatient Management Software (OMS) and proposing solutions to reduce waiting times. Many hospitals around the world apply solutions to overcome the problem of long waiting times in outpatient clinics such as hospitals in the USA, China, Sri Lanka, and Taiwan. These clinics have succeeded in reducing wait times by 15%, 78%, 60% and 50%, respectively. Such solutions depend mainly on adding more human resources or changing some business or management policies. The solutions presented in this article reduce waiting times by enhancing the software used to manage outpatient clinics services. Both quantitative and qualitative methods have been used to understand current OMS and examine level of patient's satisfaction. Five main problems that may cause high or unmeasured waiting time have been identified: appointment type, ticket numbering, doctor late arrival, early arriving patient and patients' distribution list. These problems have been mapped to the corresponding OMS components. Solutions to the above problems have been introduced and evaluated analytically or by simulation experiments. Evaluation of the results shows a reduction in patient waiting time. When late doctor arrival issues are solved, this can reduce the clinic service time by up to 20%. However, solutions for early arriving patients reduces 53.3% of vital time, 20% of the clinic time and overall 30.3% of the total waiting time. Finally, well patient-distribution lists make improvements by 54.2%. Improvements introduced to the

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patients' waiting time will consequently affect patients' satisfaction and improve the quality of health care services.

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## Introduction

Patient flow is the most critical factor within the outpatient clinical settings, as it directly affects the patients' health and their satisfaction level. Outpatient clinics and their staff members are involved in a variety of activities, where information management, accurate use of data, appropriate allocation of resources, and timely execution of processes are all necessary to maintain the patient flow within the clinic [1,2].

The main motivation of this article is to integrate health care management systems within outpatient clinical settings in Saudi Arabia to assess their effects on improving patient flow and to address the potential challenges facing outpatient clinics. The Saudi government, through the Ministry of Health (MOH), aims to provide the best level of health care services based on modern information systems by allocating a large annual budget. According to Arab News, the MOH allocated 54.35 billion Saudi Riyal in 2013 budget –15.45% more than committed in 2011 [7]. However, one significant drawback exists in hospitals – the long waiting time of patients in their clinics – which in turn affects the level of patient satisfaction as well as the quality of the provided services. Since patients' health conditions may not be stable, extra waiting time could harm them. Previous studies confirmed that, beyond the quality of medical services, the satisfaction level of patients in outpatient services is related to waiting time [3–6].

This article has concentrated mainly on investigating current Outpatient Management Software (OMS) by studying its architecture and examining for issues affecting the waiting time. Defects have been identified in the application of the health-care electronic software systems related to both requirement and design phases. Five main problems that may cause high or unmeasured waiting time have been identified: appointment type, ticket numbering, doctor late arrival, early patient arrival and patients' distribution list. Solutions to these problems have been developed then substantiated,

analytically or by simulation, to reduce patients' waiting time and eventually raise the level of satisfaction.

The scope of this research includes the workflow inside the clinic, starting from patient arrival and then moving on to vital assessment, clinical or physical examination and then discharge. All internal procedures like vaccination and pulmonary tests and external ones like pharmacy and laboratory services are out of scope.

The rest of this article is organized as follows: Section "Related work" presents related studies. Section "Methodology" outlines the research methodology: a public Saudi Hospital chosen as a case study. Section "Case study: discussion, implementation and analysis" is focused on understanding OMS, addressing the problems, proposing solutions, and evaluation. Section "Conclusions and Future work" concludes the article and draws connections for future work.

## Related work

Many hospitals around the world have proposed solutions to overcome the long waiting time problem in outpatient clinics such as hospitals in Chicago, China, Sri Lanka, and Taiwan. The following paragraphs will explain their solutions and the progress of their improvements.

A simulation study of an Ears, Nose and Throat (ENT) clinic at the University of Illinois Medical Center, Chicago, USA was conducted [8]. Two scenarios were proposed. In the first scenario, one resident doctor has been added to the system to serve all patients' types. This solution achieves 5.29% reduction in waiting time. The second scenario has changed the appointment policy which succeeded to attain a 15% improvement.

In the sample Chinese Hospital [9], three models were presented to demonstrate how different strategies can be used to improve the performance of the outpatient patient flow. In Model A, "doctors

sharing patient” any available doctor could see any patients from the system in the first examination. In Model B, “adding volunteers”, five volunteers were introduced to the system. These additional resources reduced waiting times significantly. In Model C, “changing volunteer priorities”, changing the location of volunteers, better utilization of resources was achieved. The best reduction they have got was 78%.

Algiriya et al. described the problem of waiting time in a Sri Lankan eye hospital [10]. Their study analyzes different queues which create bottlenecks in the outpatient department. They evaluated several appointment scheduling rules with the help of a simulation model to come up with a solution that minimizes the total patient waiting time by up to 60%.

A study was also conducted in a Taiwanese hospital [11]. The researchers attempted to improve the patient flow by using mixed-type registration. They used a simulation with 7 different scenarios to calculate the waiting time and the percentage of improvement. Their wait time reduction was 50%.

Another study attempted to solve the long wait times in a Hong Kong primary care hospital [12]. The methodology used to gather information about the issue was surveys. The reasons for long patient waiting time were the increases in the volume of patients and the staff turnover rate for the primary clinic during seasonal period.

These solutions depend mainly on adding more human resources or changing business or management policies to improve wait times. This may not be sufficient as the applied software services in outpatient clinics need to be addressed as well. The main aim of this article, is to study the current patient flow from a software perspective to reduce the waiting time while utilizing the current available resources.

In general, health information system (HIS) architecture is a complex portrait of how different software modules communicate with each other using centralized services and bus integration layer called “middleware” or sometimes called Integration Engine (IE). The outpatient software is an integrated software that communicates using a service bus. Making changes or development in any software is very costly because most health information systems are based on studies and several years of knowledge. In addition, requesting changes in system architecture is a very long process because it involves interconnected software which must be studied carefully for the impact of changes before introducing any development [13].

This study focuses on the outpatient clinics in Saudi Arabia and the time it takes the patient to

end her/his visit to the clinic. Moreover, this study has addressed missing requirements of the current outpatient clinics management software and the reasons behind long wait times. A large public hospital which provides healthcare electronic systems in its outpatient clinics was selected as a case study. The primary research questions in this article are:

- How enhancing OMS will improve the waiting time in Saudi Arabia outpatient clinics?
- What are the missed requirements that need to be considered to improve the outpatient system?

## Methodology

To address the problems of patient flow in outpatient clinics and the reasons behind long wait times, both quantitative and qualitative methods have been considered.

Data collection, Fishbone analysis, interviews and survey methods have been used to study and analyze current systems in outpatient clinics. Real data has been collected from one of KSA Hospital’s Outpatient Management Software (OMS) using Oracle database and for the referral software using a Microsoft SQL server database. The consultant and salary information have been taken from Enterprise Resource Planning (ERP) using an Oracle database. A Fishbone cause-and-effect tool has been chosen for analyzing the factors that have direct impact on patient flow from different perspectives. Fishbone analysis [14] is a diagram created by Kaoru Ishikawa in 1968 showing the root causes of a specific event including Method, People, Measurement, Management, Environment and Machine. Fishbone is used to study the process from inside the outpatient management and find the root causes of the problem.

Interviews were arranged with the staff members, managers, and software users to determine the information collected within the planning, design, and implementing phases in order to feed the Fishbone analysis. Moreover, the appointment queue data for data analysis is extracted from outpatient clinics systems.

Surveys were used to measure the satisfaction level of patients from an outside perspective and to identify problems and where the majority of problems lay. The sample size was 175 patients. The survey was sent using web link and site visits to a public hospital in Riyadh. The highest response rate falls under the age category of 26–35 years constituting 41.1% of the total respondents. Moreover, the majority of respondents were females (61%). In term of the respondents’ educational lev-

els, almost half of them were bachelors. [Appendix A](#) presents the survey's questions and their results. The survey's questions are designed according to patients flow in the clinic. The results of the survey have shown important problems. For example, when the patients were asked when they started counting their waiting time? 43.2% said from the arrival time, 56.8% said from appointment time. Also, 56.8% of patients agree that the clinic management informed them to come on time while 43.2% said they have not been informed to come on time. From the survey, we have identified the most important reasons behind long wait times which directly affect the quality of service.

After applying the above methods and conducting deep analysis, several problems have been addressed. Moreover, five solutions have been proposed and their impact on patients' waiting time have been tested either analytically or by simulation as will be illustrated in the following section. In the following sections, recommendations to hospital management on how to reduce patient waiting time and improve the quality of health care services will be provided.

## Case study: discussion, implementation and analysis

A case study has been selected to identify the obstacles that stand-in the way of patient flow in the healthcare facilities. The case study "KSA-hospital" is one of Saudi Arabia's MOH's biggest hospitals using state-of-the-art technologies. The outpatient service in the selected hospital benefits a huge number of patients in different medical specialties, with around 1300 clinic visits per day excluding medical procedure visits. The higher management would like to increase the patient satisfaction by minimizing the clinical visits time. This includes patient arrival, nursing assessment, physical examination, and other treatment or procedures which vary from specialty to another.

The biggest challenge is to identify the reasons behind the long waiting time in the outpatient clinics since this wait time aspect is the most important measure to increase patient satisfaction, resource utilization, and overall clinic management.

The following sections discuss our findings and present each identified problem and evaluation for the proposed solution either analytically or by simulation. To run simulation experiments, Simio [15] has been used. Simio is a tool for building and executing models of process dynamically. Simio acts out and displays a 3D animation of the behavior of

system over time. It helps to see proposed changes in the system in simulation before building these changes in real systems. The impact of each proposed solution on the waiting time will be presented separately. Consequently, significant decreases in the total waiting time could be achieved if all solutions are adopted.

## Findings and solutions

This research has identified some root causes of the problems affecting the patient flow based on Fishbone analysis. The article has concentrated on problems causing the highest or unmeasured waiting time and link them to the software component within the OMS, including:

- Appointment type problems in *scheduling* software,
- Ticket numbering problems in *queuing* software,
- Doctor clinic reporting in *time attendance* software,
- Early arriving patients in *queuing* software,
- Missing flow problem (doctor distribution list) in *scheduling* software.

In the following Sections "Appointment type problem and solution" to "Patient distribution list" each one of the above problems will be presented, analyzed and the proposed solution is presented.

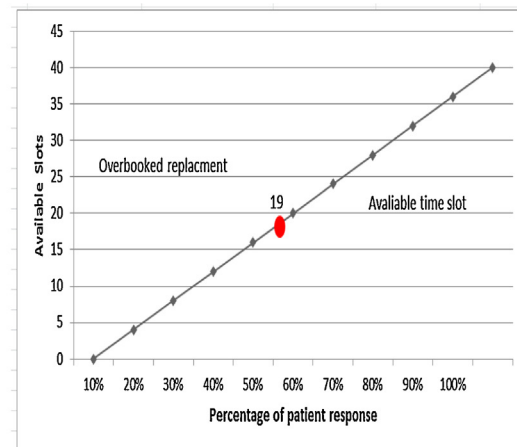
## Appointment type problem and solution

Statistical analysis of real hospital data was taken in the period from 2012 to 2014. The data shows a high increase in the number of referral and no-show patients which introduces new type of appointments called "overbooked". This causes a problem because the overbooked appointment does not include a specific appointment time.

After analyzing the problem, this study proposed a solution that could achieve the same management goals by utilizing all appointments due within 48 h from the appointment time. The idea of this proposal is to deal with overbooked appointments as an appointment waiting list and send a short message to the patients using the reminder and appointment confirmation services. The confirmation mechanism helps to ensure the patient will report to the clinic. In case a patient is unable to visit the clinic, they can send a cancellation note to the KSA-hospital confirmation gateway.

To verify the solution, a sample of 94 appointments in one day were taken, covering 10 clinics and 11 consultants. The number of no-shows for that day was 40, which means 43% of patients did

Number of Appointments	94 Appointments
Number of Clinics	10 Clinics
Number of Consultants	11 Consultants
No Show patients	40 patients (43% of Appointments )
Number of Overbooked Appointments	19 appointments
Clinic Utilization	57% of clinic is utilized

(a) Sample clinic data for January 4<sup>th</sup> 2015

(b) Probability of appointment cancellation responses and resulting available slots

**Figure 1** Appointment type problem and solution sample.

not show up and the consultant examined only 57% of the patients. The overbooked appointments on that day were 19 appointments as shown in Fig. 1(a). Applying the proposed solution, Fig. 1(b) shows if 10% of patients responded to the system, then four available slots can be replaced with overbooked appointments. If 50% of patients responded, that means all overbooked patients will have a booked appointment on that day. If 100% of patients sent a cancellation response before the appointment date, a total of 20 extra slots will be available. These available slots can be utilized by the new referral appointment daily requests.

### Ticket numbering problem in queuing software and solution

The ticket number is generated in a serial order regardless of the appointment time, but calling the patient occurs according to the appointment time which confuses the patients about when they will be seen by hospital staff. The patient assumes that if her/his number is lower than another patient, then s/he has right to be served firstly. This behavior is called patient experience or user experience in human computer interaction fields.

Using a serial number generated according to the appointment time regardless of arrival time could probably provide a reasonable solution to the issue and gives the overbooked or walk-in a priority in case there is an empty slot. If a patient is late, the system will automatically consider the patient as an overbooked or walk-in patient. Since the percentage of overbooked is around 30% of the overall

appointments, the same percentage can be used to reduce the patient waiting time.

### Doctor clinic reporting problem and solution

The consultant's attendance time has a direct impact on the patient's waiting time, especially for the first appointment both in the morning and the afternoon sessions. Fig. 2 shows the average consultant late time in minutes for 8 weeks. A sample of 5606 visits in 2 months for two sessions has been taken. The morning session starts at 8:30 AM and ends at 12:00 PM and the afternoon session starts at 1:00 PM and ends at 4:30 PM.

The average late reporting of consultant to clinics was between 20 min and 49 min, leading to dissatisfaction of the patients who wait for a long time after vital signs being checked. The impact of ignoring the Time Attendance Software (TAS) to monitor the consultant attendance has resulted in losses for the KSA-hospital ranging between 26,879 SR up to 65,843 SR per week. This calculation covers 378 consultants with average salary 3.57 SR per min.

By implementing the idea of card access, the software can detect the doctor sign-in by reading the log of Access Control Software (ACS). ACS will send the first log of the doctor to the TAS and human resource software through a web service.

Simulation results for current clinic average waiting time (AWT) are shown in Fig. 3. The figure shows the flow of patients in the clinic where the circles represent the flow steps and the arrows are used for calculations. The current situation is indicated as *Before*. In the same figure the simulation



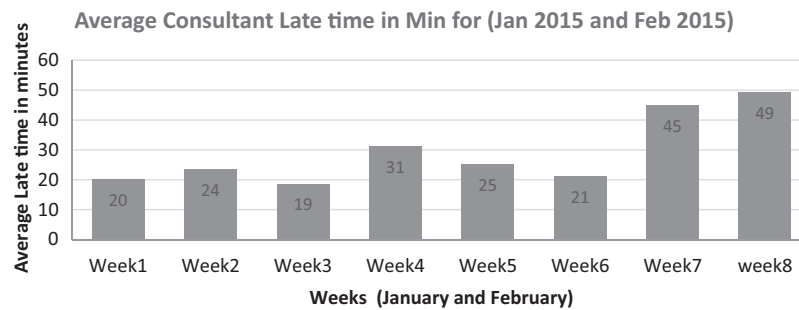


Figure 2 Average doctor late time in minutes for (January 2015 and February 2015).

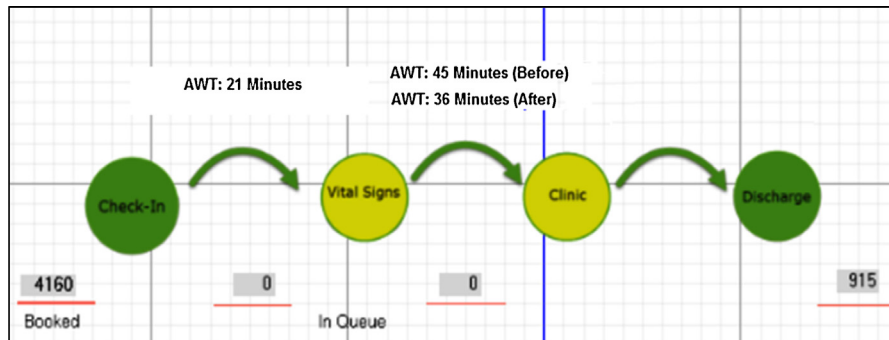


Figure 3 AWT before and after reporting doctor attendance time.

results for the proposed solution and the impact on clinic AWT is shown and indicated as *After*.

By assuming that doctors start on time and running simulation experiments on the same hospital data, the Overall Waiting Time drops down to 20% (3.1 min as an average for each session). The consultant doctor attendance time is not the only factor affecting the waiting time. Some effects are not clear, particularly because of late or early arrival of patients.

### Early arriving patient problems and solutions

Another problem related to ticket queue number is the early arriving patient. Because the queue number is given according to the arrival time regardless of the appointment time, the patient comes very early to the clinic. Fig. 4 shows that the number of check-in patients versus expected or booked patients for one-day sample. This makes the waiting time longer because the patients assume that the appointment time runs from the check-in time to discharge time. This problem occurs because of the conflict between the outpatient management and medical staff management inside the clinic.

The clinic does not expect any patients between 6:00 AM and 8:00 AM, while the patients who arrived

before 8:00 AM were 22. The clinic official time starts at 8:30 AM, and the number of patients waiting reached 62. The clinics expected only 13 patients at that time and the clinic had only seven consultants in the morning session.

The service after patient check-in is managed by doctors and nurses. Inside the clinic, the patient's turn is according to the patient arrival time; First In First Served (FIFS) not First Appointment First Served (FAFS). The main cause of this issue is the misunderstanding and lack of collaboration between the outpatient's department and the medical department.

Fig. 5 shows the result of 2000 sample visits made. Simulation is used to see the impact of patient arrival time on Vital Waiting Time (VWT). According to the current data, the AWT as shown in Fig. 5 and indicated as *Before* is 21 min. However, if the clinic arrival control system is applied, the number will go down to 10 min i.e., 52.3% improvement as shown in Fig. 5 and indicated as *After*. In order to solve the current issue, in addition to the instruction that should be printed on the appointment slip, the Queue Software should not accept any patient 30 min before appointment time. This function is called clinic arrival control, and the software should reflect the policy and it should not be different.

### Number of Arrived Patients vs. expected

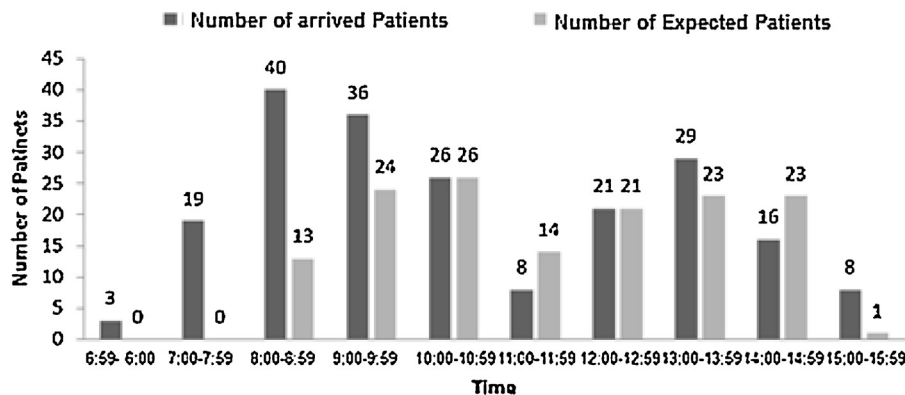


Figure 4 Early arriving patients for one day.

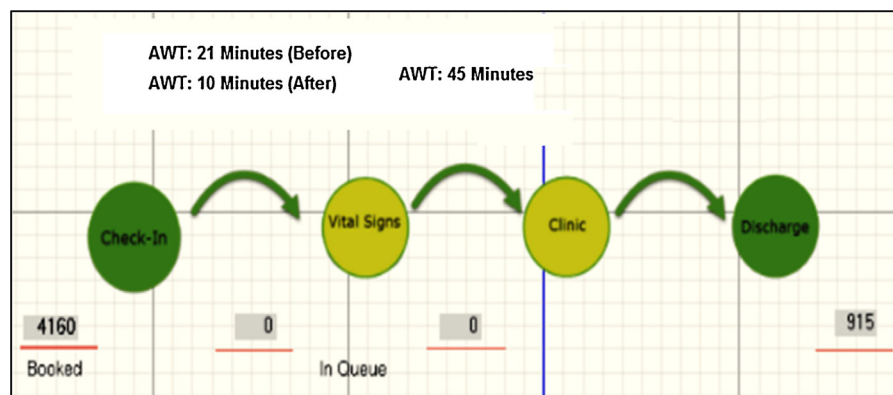


Figure 5 Vital Waiting Time before and after preventing the early arriving patient problem.

Table 1 The impact of time attendance and clinic arrival control on Overall Waiting Time.

Waiting time type	Current process	Proposed solution (simulation)	% of improvement
Vital Waiting Time	21 min	10 min	53.3% of VWT
Clinic Waiting Time	45 min	36 min	20% of CWT
Overall Waiting Time	66 min	46 min	30.3% of OWT

If the Time Attendance and Clinic Arrival Control are implemented and integrated with the Queuing and Human Resource Systems, the Clinic Waiting Time (CWT) and the VWT will be reduced as shown in Table 1.

#### Patient distribution list

Missing data requirements is another factor affecting patient's waiting time. The clinic booking uses one consultant's name, but consultants work with their own team of assistant consultants. Therefore, this study has figured out that missing requirements that affect clinic service time which in turn affects the Clinic Waiting Time.

Each consultant/doctor has one assistant consultant per 10 patients. The assistant consultant is part of a team helping the consultant to examine the patients. For example, if the consultant has 35 patients s/he will have two assistant consultants helping her/him in the clinic. The current booking system schedules all patients under one consultant's name. That means if a consultant has a team of assistants, the assistant name is not reflected in the clinic schedule. So, if the consultant has more assistants s/he can accept more patients however in the booking software, the time is not quite reliable.

In the implementation phase, simulation will be used to measure CWT by using the patient distri-

**Table 2** CWT before and after applying the clinic distribution list.

Number of clinics	Average CWT without distribution list	Average CWT With distribution list	% of improvement
Two clinics	196 min	134 min	31.63%
Three clinics	64 min	41.6 min	35.00%
Four clinics	24 min	11 min	54.17%
Five clinics	9 min	6.2 min	31.11%

bution list. In [Table 2](#), the CWT is changed when a new room is added and counted, assuming the time from current observation and the result according to the expected number of rooms for 100 patients. By assuming the clinic without distribution list, it takes 18 min service time for each patient. The time needed for the patient to arrive to the clinic is 4 min. With distribution list, the clinic service time is 15 min and the time needed for the patient to arrive to the clinic is 2 min. [Table 2](#) shows that using a distribution list improves clinic service time.

Based on simulation results, there is no difference between one or two clinics with or without a distribution list due to the small number of rooms where it is easy for the consultant to manage with one assistant. However, if the doctor has more than two rooms, it will be difficult for her/him to manage without software. The improvements can be seen when the distribution list is used for more than two rooms. Beyond the improvement in the clinic service time, the outpatient clinic management can monitor the performance of the doctor and her/his assistants separately, which will help in future care and staffing decisions.

## Conclusions and future work

Saudi hospitals, like hospitals around the world, are seeking quality in the provided medical services. To achieve such quality, solving long wait times in outpatient clinics is a necessity. This article addresses central problems affecting waiting time by studying current Outpatient Management Software (OMS) used in KSA clinics. Solutions have been proposed to enhance current OMS. Analytical and simulation experiments have shown a decrease in waiting time that reaches in some solutions 54.2%—consequently affecting patients' satisfaction and improving the quality of health care services in the Kingdom of Saudi Arabia. The application of the proposed solutions requires changes to the OMS components and increasing awareness among the medical staff and patients.

Several recommendations from both software and business point of views that affect patients' flow need to be studied and applied in the future.

From the Outpatient Management Software it is recommended to:

- Implement the proposed solutions in KSA-hospital.
- Integrate clinical software and single sign on.
- Use mobile for auto check-in since KSA-hospital is a huge organization and the patient need to follow up the order from anywhere.
- Use dashboard in queuing management system.

From the business point of view it is recommended to:

- Solve the no-show problem by applying a policy that closes the patient's file if the patient does not show three times, for example.
- Attain cooperation between clinical and outpatient management systems to reduce the conflict and achieve patient satisfaction.
- Rearrange the clinic layout according to the patient flow.
- Create a committee reporting to high management and working on reducing the clinic service time.

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## Competing interests

The authors declare that they have no competing interests.

## Ethical approval

Not required.

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## Appendix A.

See [Tables A1–A4](#).

**Table A1** Patient visit survey.

Satisfaction questions	Always	Most of the time	sometimes	Rarely	Never
1. Do you take the medicine right away after your appointment?	45%	30%	18%	5%	2%
2. Is there any one from your relatives who helps you to get your Medical services?	16%	15%	30%	17%	22%
3. How is your ability in use the self-service machine for check-in service?	23%	17%	26%	20%	14%
4. Do You visit the hospital if you do not have an appointment? To complete procedures, get a report or appointment, for instance	9%	11%	35%	23%	21%
5. Nurse's explanation for the expected waiting time	12%	11%	21%	22%	34%
6. Nurse's explanation for the next step and what you should do	18%	18%	27%	21%	16%
7. How well did the consultant explain your case during the examination?	26%	26%	32%	11%	5%
8. Have you waited for your appointment for more than one hour?	27%	20%	34%	10%	8%

**Table A2** Satisfaction level of clinic visit in outpatient clinic.

How satisfied you are:	Extremely satisfied	Satisfied	Barely satisfied	Not satisfied	Extremely not satisfied
1. The length of time you had to wait to get a new appointment from the reception	11%	27%	42%	13%	7%
2. The Reception service time	12%	37%	41%	5%	4%
3. The nursing service time	14%	31%	38%	14%	4%
4. Number of waiting patients for one physician	12%	17%	37%	23%	12%
5. The length of time, you spent waiting before the first call	9%	24%	44%	15%	9%
6. The length of time, you spent waiting before the second call	8%	25%	34%	26%	7%
7. Your visit overall	11%	19%	36%	19%	15%

**Table A3** Waiting time starting time.

When do you start counting your waiting time?

Answer options	Response percentage
Arrival time	43.2%
Appointment time	56.8%

**Table A4** Confused in appointment time.

Have you been informed to come early to your appointment regardless of your appointment time?

Answer options	Response percentage
Yes	56.8%
No	43.2%

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