REDUCING WAITING TIME AND IMPROVING PATIENT FLOW IN PUBLIC SECTOR HOSPITALS USING BUSINESS PROCESS ENGINEERING AND SIMULATION

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ABSTRACT. The goal of healthcare organizations is to provide efficient and effective patient care while ensuring patient satisfaction. One significant challenge in achieving this goal is managing patient flow and reducing hospital wait times. Almost 550 randomly selected patients were part of the study. Information was obtained from respondents by using pretested questionnaire and further descriptive statistics were used for analysis. In this study, the application of business process engineering (BPE) was explored as a solution to increasing patient flow and reducing waiting times in hospitals. The study examined the present patient flow in public hospitals, which was a crucial component of the research, it also identified constrictions and inefficiencies in the current process and showed how the use of different methodologies helped in eradicating the problem. The results of the conducted study revealed that the implementation of BPE methodologies can significantly improve patient flow and reduce waiting times in hospitals, leading to increased patient satisfaction and improved operational efficiency. According to these results, using BPE techniques significantly reduced patient wait times from an average of 118 minutes to 19.29 minutes. The findings of this study have important implications for healthcare organizations looking to improve patient flow and reduce waiting times and highlight the potential of BPE as a valuable tool for healthcare process improvement.

Keywords: Hospital, Healthcare services, Waiting time, Patient satisfaction, Business Process Engineering (BPE), Business process modeling (BPM), Simulation, Anylogic, Business Process Engineering (BPE), Business Process Reengineering (BPR), Business Process Modeling Notation (BPMN).

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INTRODUCTION

Hospitals strive to offer the best care possible while patients are in the greatest need. When someone requires urgent medical care and doesn't want to wait, they go to the hospital. But with the rising demand for healthcare services, he will likely spend a lot of time just waiting in the hospital queue. Hospital wait times continue to be the biggest problem facing our healthcare system. Due to capacity concerns, the government healthcare system faces difficulties [1].

Patients at public hospitals continue to endure lengthy wait times despite improvements in healthcare equipment and procedures, which causes annoyance, lowers satisfaction, and has a detrimental effect on the quality of the patient's overall health. Poor patient flow, process impediments, and a lack of resources are to blame for long wait times and pressure on the healthcare system. To offer patients with effective, highquality care and to preserve public confidence in the healthcare system, healthcare facilities must address this issue.

With a countrywide network of medical services provided by 796 hospitals, Pakistan's public health sector is able to accommodate the greatest number of patients [2]. In a public hospital, the patient flow process consists of numerous steps, beginning with registration at the front desk, then triage assessment by a nurse, diagnostic procedures, medical treatment, discharge with instructions, and finally billing and payment. Due to systemic bottlenecks and ineffective patient flow, this procedure might take a while, and patients frequently encounter lengthy wait times in public hospitals. In order to deliver high-quality, effective, and patient-centered treatment in public hospitals, the patient flow process must be improved.

This research emphasizes how Business Process Engineering (BPE), Business Process Modeling (BPM), and Simulations are used to evaluate, create, and enhance current organizational processes. These techniques are used to shorten wait times and enhance patient flow in public hospitals. Simulations use computer software to model and replicate a real-world process, allowing healthcare managers to test and evaluate different scenarios before implementing changes. This can help identify congestions and inefficiencies in the patient flow process, and recommend changes to reduce waiting times.

AnyLogic is simulation software that allows you to model and analyze complex systems. It combines aspects of several simulation paradigms such as agent-

based modeling, system dynamics modeling, and discrete event simulation, to provide a versatile and powerful platform for modelling a wide range of systems [28]. Manufacturing systems, logistics networks, healthcare systems, financial markets, social and economic systems, and many other types of systems can all be simulated using AnyLogic. The software has a drag-and-drop interface and an integrated programming language, making it simple to use for both experts and novices. AnyLogic includes a variety of analysis tools in addition to its modelling capabilities, allowing you to analyze and optimize the behavior of your models. Among these tools are statistical analysis, optimization algorithms, and animation capabilities.

Business Process Engineering involves analyzing and re-designing the current processes within a healthcare organization. This helps streamline workflows, reduce delays, and improve patient flow by identifying and removing obstacles that slow down the process [3].

Business Process Modeling involves creating visual representations of workflows, such as flowcharts or diagrams, to help understand the interconnections and dependencies between different steps in the patient flow process. This helped in the identification of opportunities for improvement and making changes to reduce waiting time and improve patient flow.

The introduction of online appointment booking through mobile app helped in lowering these wait times in several ways. After analyzing this chaotic circumstance, we came up with a solution of a Mobile App for booking online appointments. By allowing people to plan appointments at their convenience, online booking contributed to a more distributed appointment volume and decreased the need for lengthy patient wait times. Additionally, the usage of mobile apps gave patients real-time information regarding appointment availability and queue status, helping them plan their arrival at the hospital. Online appointment scheduling additionally decreased hospital staff workload, giving them time for more hands-on patient care.

Background: Business Process Reengineering (BPR) is a management strategy that aims to increasethe efficiency and effectiveness of business processes. BPR was first introduced in the1990s and has since become a popular management strategy for businesses looking toimprove their operations. Implementing business reengineering can be described as making deliberate, fundamental changes to business procedures in order to achieve radically improved performance[4].

"Amanagementtechniquethatrethinkscurrentpractic esandproceduresinbusinessand its relationships" is the definition of business process re-engineering. It uses fundamentalandradicalmethodstochangeoreliminatenon-value-addingoperations,andtorestructuretheprocess,structure,and dcultureinanefforttoincreaseunderlyingprocess efficiency. In BPR method, first, we should map the existing clinical process anddecompose it into activities that are involved in the process. The mapped process isnamed “as-is” process. We must identify all non-value-added activities and extra stepsinside the therapeutic process that has been outlined [5]. The simulation evaluates the"as-is" state and forecasts the performance of the "to-be" design prior to the actual implementation in order to fully comprehend the process [6].

Hammer suggests using BPR to achieve radical improvements through a clean,straight-forward approach instead of using inefficient old processes with technology[7]. BPR arose from the need for businesses to streamline their processes and becomemore competitive in the market. Business process reengineering (BPR) is a radical rethinkingandredesignofbusinessprocessestoachievesignificantimprovementsinperformancesuchasincreasedefficiency,lowercosts,higherquality,andhighercustomersatisfaction.

Business process Reengineering consists of five steps including defining vision, identification of process, understanding existing process, definingmethodology andpreparing a prototype. In “identify the process” step we should find our which process we are going to redesign based on cost analysis or revenue generation. In“ understanding the existing process” stage carefully observe and understand existing process inorder to avoid repetitive mistakes. Next step “Defining Methodology” is essential and it involves selecting method to redesign process. Eventually design a pro to type for new process [8].

BPR has been used in healthcare to improve the efficiency of patient care processes, lower costs, and improve care quality. BPR has been used in the manufacturing industry to streamline production processes, reduce waste, and improve product quality. It hasalso been used to smoothen processes related to loan approval, customer service, and financial reporting in the banking and finance industry. BPR has improved supply chain management, reduced waste and costs, and improved customer service in the retail industry. Business process reengineering (BPR) has been used in the public sector toboost the efficiency of government processes, and improve citizen services. BPR hasbeen used in the IT industry to optimize software development processes, reduce projectdelays, andenhance softwareproduct quality.

According to Caccia Bava, hospital BPR deployments in the healthcare sector arenow more successful than they were in the past. To further explore the implications of the or etical success determinants, they also performed empirical testing. An other as pect of hospital administration to take into account is the hospital's condition. A performance monitoring system

was developed by Kumar et al to reduce inefficiencies in the health care supply chain. He in buch also investigated how to raise the health care supply chain's effectiveness. According to Francis and Alley (1996), BPR solutions can bedivided into three groups: IT solutions, human resources, and physical space. As ahealthcare interpretation of BPR, Probert et al reintroduced the term PPR (Patient Process Re-engineering)[6].

In the healthcare arena, simulation has emerged as a helpful tool, notably for optimizing patient waiting time in diverse healthcare settings. The research conducted at Duke Cancer Institute applied simulation to improve patient flows. First they developed discrete event simulation model in order to find out patient waiting time and to determine bottlenecks in patient flow[9]. Another research conducted in China highlights benefits of simulation in healthcare to find the approximate Pare to optimal patient flow distribution. To validate and execute the Simulation strategy, research focused on acase study based on real data is conducted. The case study findings suggest that therecommended Pareto optimum patient flow distribution can improve the overall performance of the hierarchical system[10].The research conducted at Akron used simulation to trace the patient flow in radiology department to observe where waiting lineexists and to determine the length of time each individual spend waiting for resources.The study suggested the addition of one radiologist to existing five provide reductionof waiting time.[11] but this solution is kind ofunreal sometimes it’s not possible toappointsix doctorsat time.

Another study that was carried out by M.A. Ortiz and P. López-Meza used simulation model to improve the patient flow at out patient internal medical department. The study designed 3 improved scenarios suggested by medical staff of department assess the sescenariosthroughthesimulationmodelwithoutimplementingthemontherealsystem.The main focus of the study was Patient waiting times and Patients satisfaction rates. In Scenario 1, the internistis subjected to financial penalties for each cancelled appointment, with the goal of eradicating medical agenda cancellations. Scenario 2 offers extending Internist 2's operating hours on Tuesdays and Wednesdays (from 8.0 to 14.0),which would increase the internist's installed capacity. Finally, Scenario 3 suggests scheduling Internist 3 on Tuesdays, Wednesdays, and Friday sat the time suggested in Scenario 2. Scenario 3 was selected as best improvement choice with statistically equal or higher waiting times.[12].

Patientwaitingtimeisawidespreadissueinmanypublichospitals,withnegativeconsequences for both patients and healthcare providers. Finding ways to shorten waittimes and enhance patient flow in public hospitals has gained more attention recently.The majority of patients expressed unhappiness with the services they received andcited long waiting periods as the main cause of their dissatisfaction in one significantstudy in this area that was carried out in Northern Nigeria. According to the study'saverage time observation of 85, waiting time was much longer than waiting time forpatient checkups. They came to the conclusion that healthcare facilities and hospitaladministrators should address deficiencies in internal procedures targeted at reducingwaiting times and establishing a successful healthcare delivery system rather than offering a specific solution to the issue[13]. Another study was conducted on the sameissue, in the same region and it applied business process re-engineering techniques toevaluate different solutions. The following areas should be the focus of the BusinessRe-engineering Process at institutions like hospitals: automating several departmentswith cutting-edge IT infrastructure and reorganizing the system structure and culture for simple in formation flow: training and development for employees on a regular basis [14]. The research done by students of University Indonesia Depok finds that average cycle business process reduced from 28 days to 14 days with increased efficiency of78.73% using BPR and MIR approach[15].

RESEARCH METHODOLOGY

This section outlines the approach taken for conducting result. The research conducted in order to reduce wait times in hospitals used two approaches questionnaire, simulationand modeling.

Questionnaire: Ability to make contact with audience and gather responses from a relatively largenumber of people in scattered and possibly remote locations is one of the main benefitof questionnaires[16].In order to gain insight into the opinion of targeted populationrelated to wait times a survey was conducted using both online and physical questionnaire. The questionnaire was designed to gather data in a range of areas, including therespondents' experience of the issue, their attitude towards it, and any potential solutions .It contain both open ended and close ended questions to get clear-cut opinion.The questionnaire was distributed to a sample of the target population, and responseswere collected and analyzed to have a better understanding of the issue and the population'sopinionaboutit.

Simulation and Modeling: Simulation is a process which involve behavior of real life functions in artificial environment[17].Simulationis the process of creating a computer-based, mathematical,andlogicalmodelofareal-worldsystem.[18].Asimulatedmodelcanbeusedasatooltoexaminesystemresponsesinvarioussettings.Simulationhasprovenasauseful toolto study resource-driven processes [19], [20]. Generating a simulation based on a "tobe" situation could be beneficial to eliminate errors and prevent unnecessary costs [21]. Business process modeling has long been used to understand, direct, and support

activities in a variety of fields [22].The modeling notation used in this research paper isBusiness process modeling notation (BPMN).In 2004 BPMN was presented as standardbusiness process modeling notation. BPMN's main objective was to offer a notationthat all business people could comprehend including business users, analyst, developersand people who manage and monitors business process. Modeling is vital step in studying the current and proposed structure of business process from system perspective.The BPMN model of Hospital as shown in Figure 8 show the Phases through whichpatient went through .It also shows how the patient pool interacts with white box pooland blackboxpool.

Steps: The research is conducted in following various steps:

1. Conducting survey inordertofind outopinionsofpeople.
2. Collectingandanalyzingthedatafromsurvey.
3. Makingsimulationmodelofproblembyusingcollecteddata.
4. MakingBPMNmodelofproblem.
5. Analyzingresultfromsimulationmodel.
6. Makingsimulationmodelofsolution.
7. MakingBPMNmodelofsolution.
8. Comparingresultofresultobtainedfrom problemand solutionsimulation.

Experiment and Results: The research paper used Aziz Bhatti Hospital Gujrat of Pakistan as a case study to inspect and examine patient flow and waiting times. The Hospital is Biggest Hospital ofDistrictandhundredsofpatientvisitit.

InHospitalspatientcameacrossdifferentstepstogetappointment.Theaveragewaittimeset by Ministry of Health(MOC) are 20 to 30 minutes (median)[6].Butdata wecollected from the survey portray a different story. The sample consists of 124 people. The data collected by survey tells us that average time spent in hospital is 1 hour and 5 minutes and some people can't even get appointment.

The results of Figure 1 and 2 shows that mostly people prefer to visit hospital on Sunday and after noon respective.

Accordingtosurvey35%spent5-10 minutes, 33.3% spent 15-20 minutes, 20.3% spent more than 30 minutes and rest of them spent more than hour in just registration queueas shown in Figure 3. Moreover in case of 41.5%5-10 minutes in consumed during checkup, incase of 36.6% 15-20 minutes and 19.5% spent more than 30 minutes during checkup rest of them spent more than one hour shown in Figure 4.

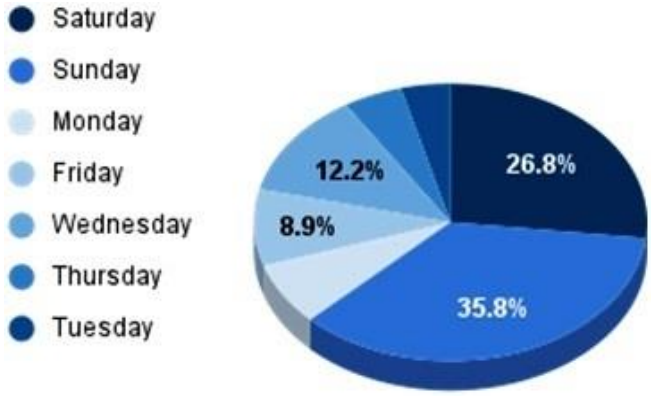

Fig.1.Preferreddayofvisiting

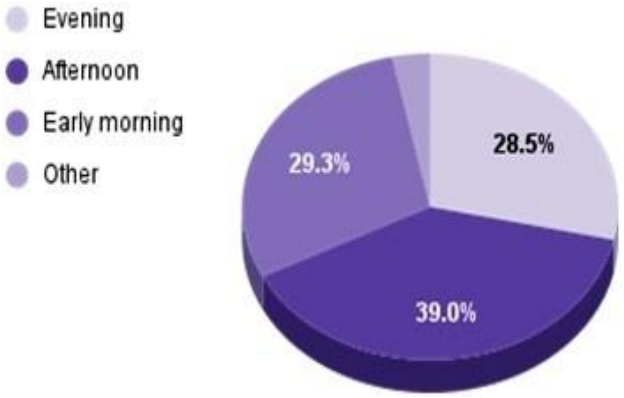

Fig2.Preferredtimeofvisitingthehospital

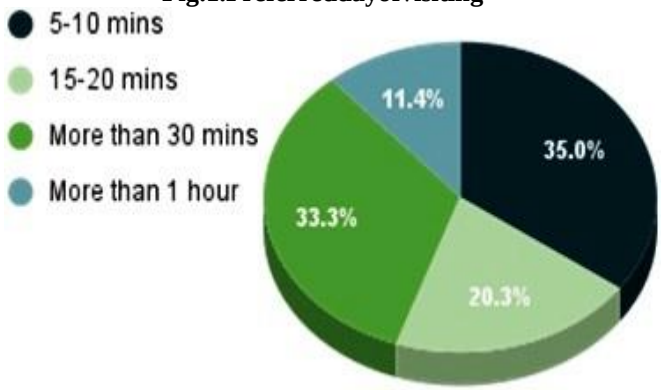

Fig.3.Timespentintheregistrationqueue

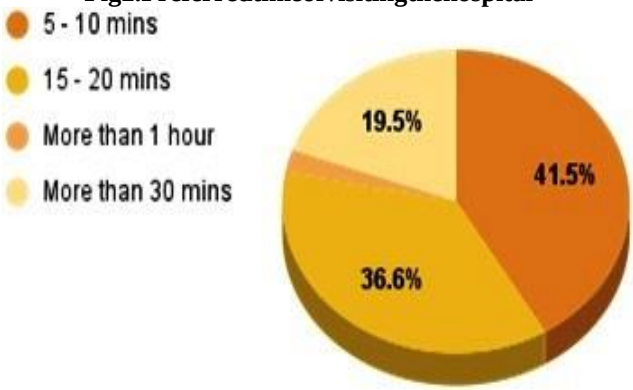

Fig.4.Timeused forpatient'scheckup

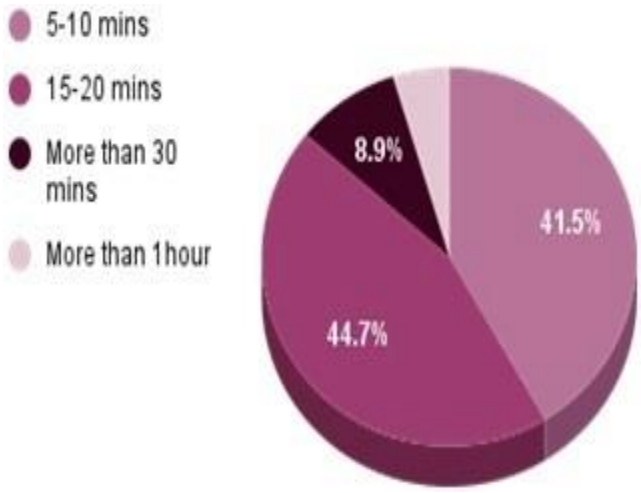

Fig.5.Timespentatpharmacycounter

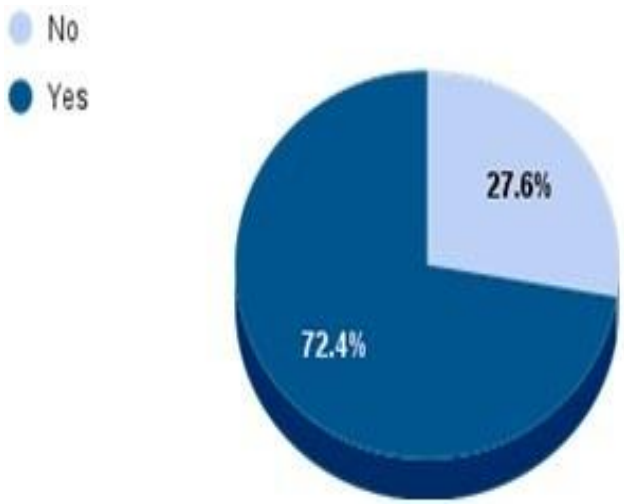

Fig.6.Patientsfacinginjusticebystaff.

At pharmacy 44.7% spent 15-20 minutes,41.5% spent 5-10 minutes, 8.9% spent morethan 30 minutes and rest of people spent more than one hour shown in Figure 5. Thesurvey reveals that in 72.4% cases staff give their turn to someone else displayed inFigure6. Thesurveyshows25.2%hastheworstexperience,34.1%hast he moderateexperienceand only 9.8% has the best experience in queue while taking appointment shown inFigure 7.

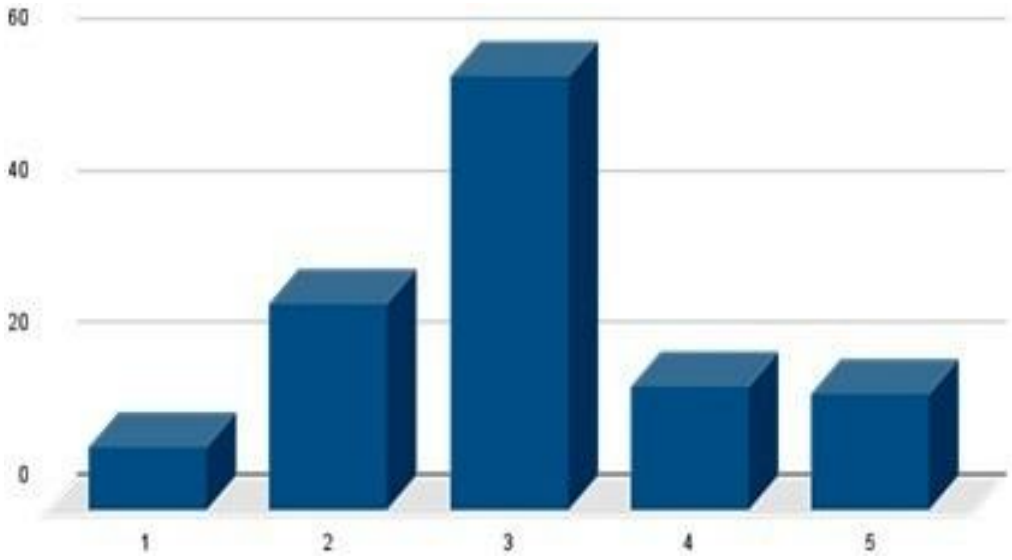

Fig.6.Patients' experience in the appointment queue

AftergatheringsurveydataweecreateaBPMN(BusinessProcessModelandNotation) of the survey problem. Business process models can be graphically representedusing BPMN (Business Process Model and Notation). It was created to give a visual depiction of every step of a business process and make it simple for both business users and technical professionals to comprehend. Element types like flow objects, gateways, events, activities, and sequence flows are frequently seen in BPMN models. A process flow diagram can be created by connecting these components; this diagram can then be used to direct the design, development, and execution of a business process. TheBPMN(Business Process Model and Notation) of hospital show flow of activities inHospital.

Patients initially travel through the registration line and wait in line to acquire appointment tokens. Once they have their tokens, patients move to the waiting area andwait in line once more. After the checkup, patients go to the pharmacy or to the specialist for more testing or an X-ray. The Figure 8 shows the BPMN model of hospital and the different phases which patient came across in order to get appointment.

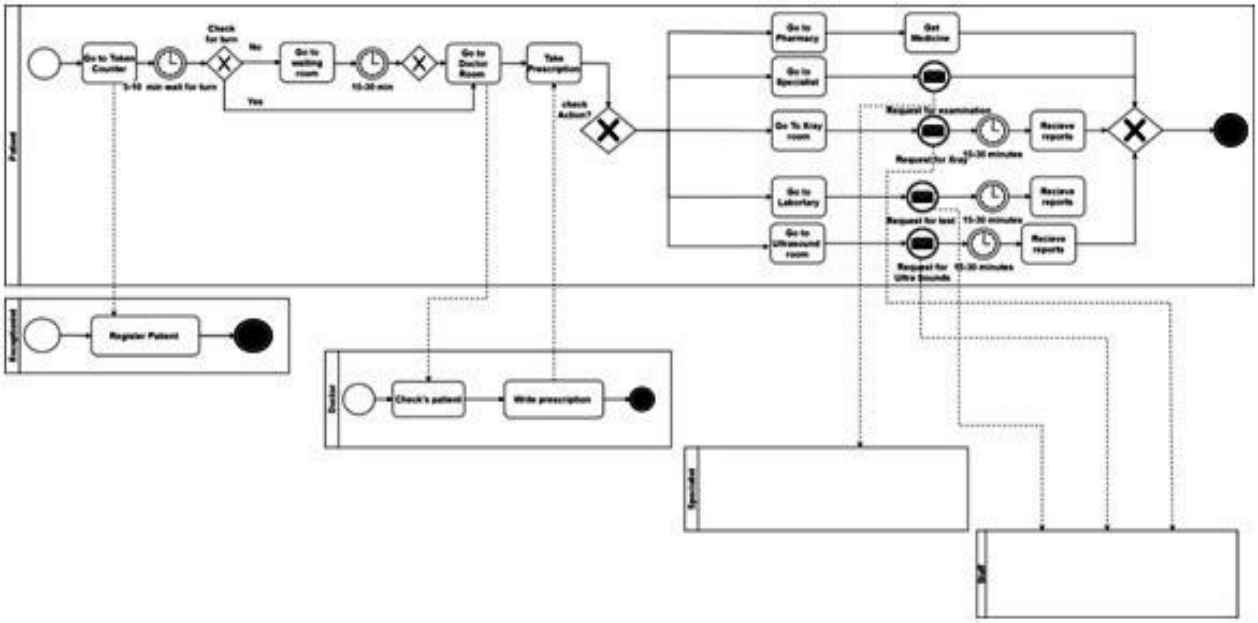

Fig.7. BPMN modelofHospital

Simulation model is developed using data collected form survey. Simulation involvescreating a model of a system, which can then be manipulated and tested to understandthe behavior of the underlying processes. We used Any logic software in order to builda Simulation model. The simulation shown in Figure 9 consists of following components:

- Source:Generatesagentsat the startofthesimulation.
- MoveTo:Movesagentsfromoneblock to another.
- Queue:This putspatientsin the queue.
- Delay:Thismeansthe patientwillwaitforsomespecifictime.
- Seize:Seizeresourcessootherpatientsdon'tuse them.
- Release:Releaseresourcesafterthepatientusesthe m.
- Schedule:Day-wisescheduleofpatientsenteringin Hospital.
- Agents:Entitiesinvolvedin thisprocessoractors.
- Time Measure Start and Time Measure End: Pair of inter related items that keep track of how long it takes agents to leave.
- Sink:Destroy agents.

Accordingtoaschedulecreatedusingsurveydata,Patient-namedagentsaregeneratedatthesource.Whenanagentiscrea ted,theTimeMeasureStartblockstartstheclocktotrack how much time the agent has been working. After utilising move to block to access the token counter, patients are then lined up in a queue to wait their turn. Patients proceed to registration, where adelay block is in use as a result of the patient' sex tended time at the registration counter. Patients then proceed to the waiting area. If a patient is the first to come, he or she will immediately grab the doctor; otherwise, he or she willhave to wait for his or her turn. The patient will take one of the advised actions basedon his health. He could visit a lab for testing, a pharmacy, a specialist, or get an ultrasound or X-ray. In the simulation, the probability is set to 0.5% and the condition isapplied usingachosenoutputblock.

The simulation model was running in accordance with the timeframe for a week.Many patients were waiting even after the model time ended, and there long lineups atthe registration desk were seen. We note that 295 percent of patients did not receive appointments after waiting for hours.

Table 1 shows that the length of stay at the hospital is 265.01 minutes (mean) and thetime spent by each patient is approximately 118 minutes but the mean waiting time of the patient should be 42minutes[23].

The creation of an online appointment system for patients is the best way, in our opinion,tosimplifytheappointmentschedulingprocedurean draisepatientsatisfactionlevelsoverall.Insteadofmakingpat ientswaithoursforappointments,hospitalscanmanage patients more effectively and schedule medical appointments promptly by developing a digital platform. The patient will not be required to spend hours in the waiting area because they can go about their daily business and be at the hospital on time for their appointment. Patients no longer need to physically wait in long lines or crowded waiting rooms thanks to mobile queues, which allow them to join a queue remotely using their mobile devices and went to hospital when their turn is near. Following a 5to 10-minute delay, the next patient will be informed if a patient cancels an appointment.Similarly,ifapatientis5to10minuteslate,thene

xtpatientwillhavetheirturn.Mobilequeueseliminatesthenee dforrealwaitingroomsandlimitspatientinteraction,fostering social estrangement and improving infection control procedures. The entirepatient experience is enhanced and the perceived waiting time is decreased because tothisconvenience.Finally,duetotheiradaptabilityandscala bility,mobilequeuingsystemsareappropriateforavarietyofh ealthcaresettings.Mobilequeuesmaybetailoredandsetupto matchtheuniquedemandsandspecificationsoftheorganizati on,whetheritbe a hospital, clinic, or other type of healthcare institution.

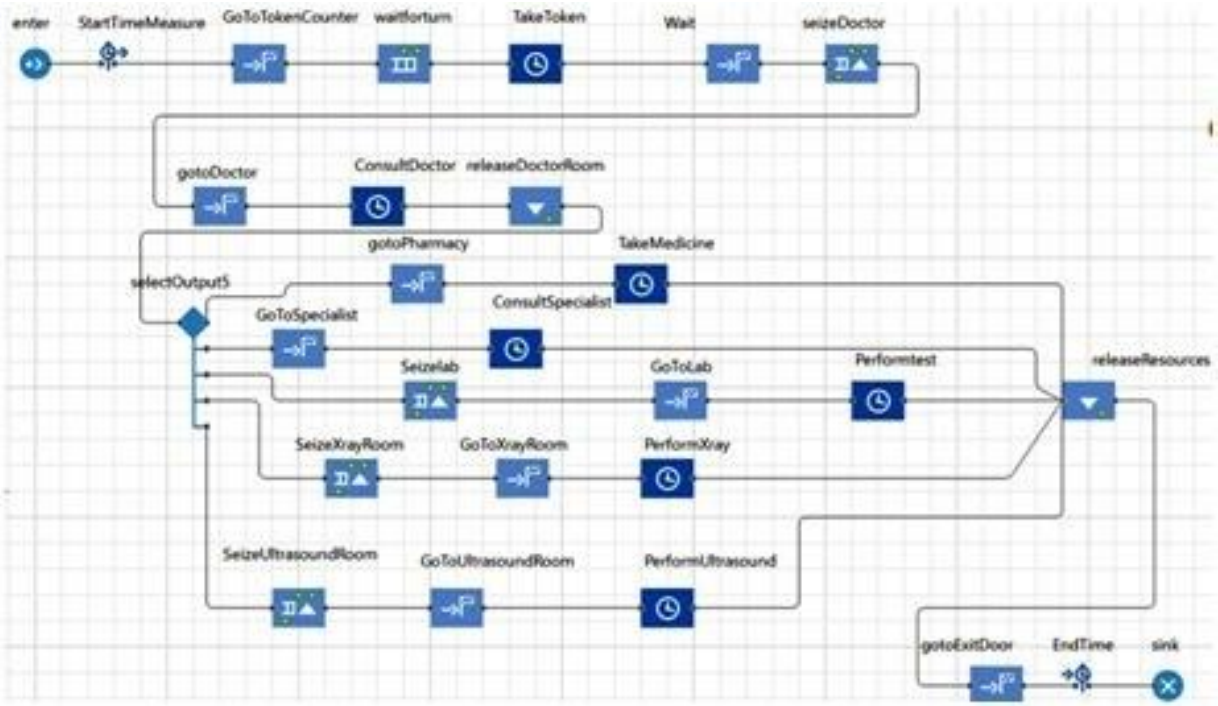

Fig.8.Simulationmodelofproblem

Table1. DataCollected fromasimulationmodelofproblem.

Mean	265.009
Min	16.164
Max	566.392
Deviation	141.951
Meanconfidence	15.853
Timespent byeachpatient	118minutes

Additionally, patients may get test results online rather than waiting several hours forthem, which will enhance their entire experience. Compared to conventional techniques, online reports provide better accessibility, real-time updates, interactivity, costand time efficiency, increased data security, and environmental sustainability. Adopting on linere porting may greatly enhance the communication of information, teamwork, and decision-making inside organizations.

In the BPMN model of the solution shown in Figure 10, the patient first logs in or registers, then books an appointment, then travels to the hospital at the scheduled time, validates the appointment, and then moves to the doctor's room to carry out the prescribed tasks. Also, using an online appointment system, the patient can see reportsimmediately. If a patient is late or doesn't show up, we can see in the receptionist process that the next patient will have their turn after waiting for 5 to 10 minutes.

Asimulationmodeloftheto-bewascreatedinordertodeterminewhetherithelpswithissue-solving and reducing wait times. In the simulation model shown in Figure 11, a patient walks into a hospital and immediately goes to the registration counter to confirm his online appointment. He arranged an online appointment, so the receptionist was already informed of his presence, so he didn't have to wait in line for the appointment token for hours. The patient will arrive at the hospital at the appointed hour, so there is no need for him to wait in the waiting room before seeing the doctor. To

achieve this behavior, Any logic's Hold block is used. Hold block uses the condition that if a variable's value is false, a patient is already in the doctor's office and other patients are not permitted to enter. With the call inject () function, patients are created. After executing the model, we see that the mean wait time drops to 22.8 minutes, with a 22-minute wait for each patient. Figure 11 depicts the patient's length of stay in the case of an online appointment.

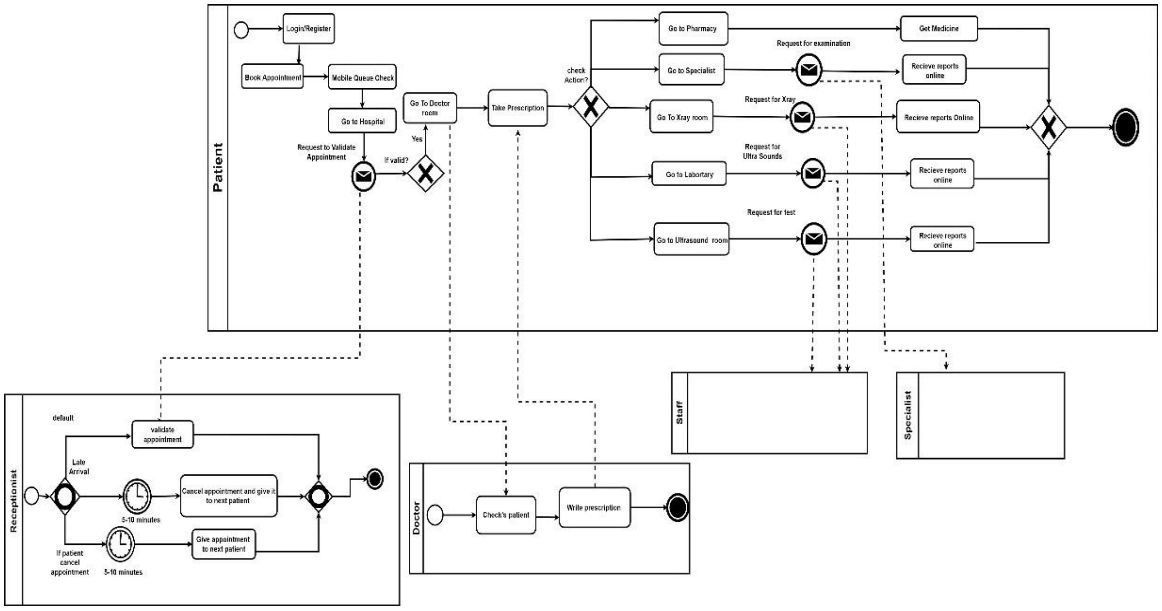

Fig.9. BPMN model of solution

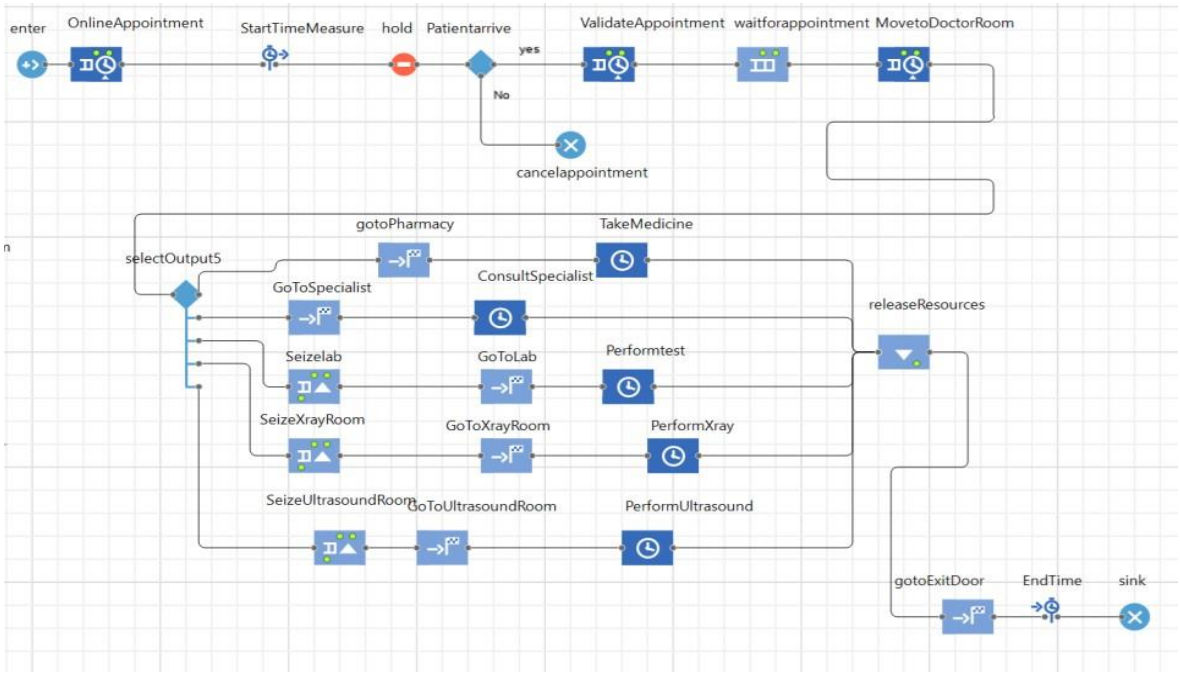

Fig.10.Simulationmodelofthesolution

Using the data from the simulation, the time distribution for each patient is shown intabular form in Table 2, which shows the mean time taken by each patient and the time taken by one patient to complete the checkup process, both of which are significantly less than the time taken by patients who donot have an online appointment.

Table2. Datacollected fromthesimulationsolution

Mean	**22.8**
Min	13.913
Max	43.6
Deviation	6.585
Meanconfidence	0.82
Timespentby each patient	22minutes

Comparing results

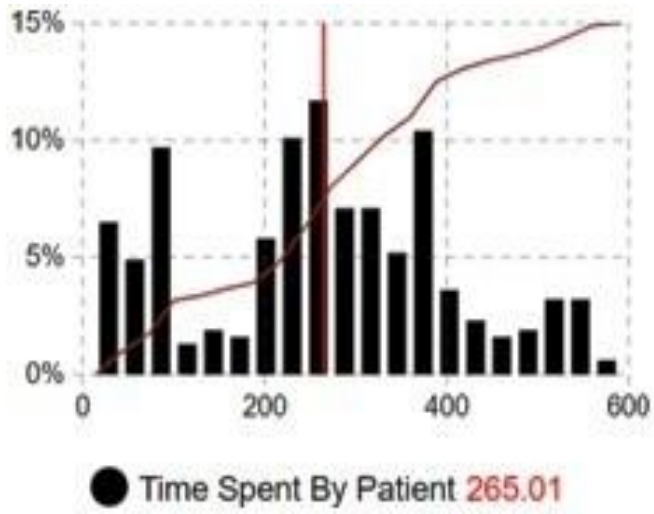

Fig.11.Time spent by patient in hospital before using online approach.

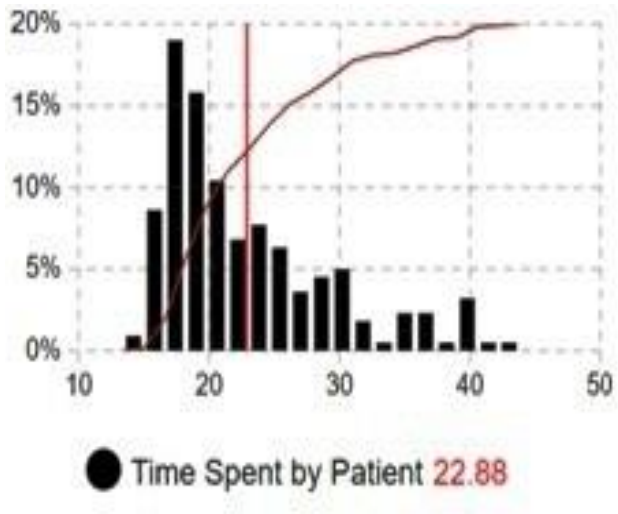

Fig.12. Time spent by patient in hospital after using online approach.

DISCUSSION

After thorough research and solution implementation, radical transformation is evident.Figure 12 shows lengthy wait times before using an online appointment system. As shown, patients must wait an average of 118 minutes before seeing a doctor, which is a relatively long wait time. Although a modest rise during peak hours, the wait timesare generally steady throughout the day. The graph also demonstrates that waiting timesfrequently surpass three hours, which could lead to patient discontent and poorer care.We can notice a considerable reduction in wait times as a result of the adoption of anonline appointment system in Figure 13 where the wait times are reduced when compared to the graph.in Figure 12.A huge improvement over the prior graph, the mean wait time has been lowered to 22 minutes. Also, wait times have significantly decreased during busy times, demonstrating that the online appointment system has increased patient flow and decreased operational bottlenecks in the hospital. The data also demonstrates that the wait time seldom surpasses one hour, demonstrating that patients may receive timely care. This demonstrate show the online appointment system works to cut down on patient wait times. Although patients can arrange appointments more quickly and are reminded of their appointment through the system, the online appointment system lowers the number of no-shows and cancellations. Overall, the contrast between these two figures show an online appointment system affects hospital wait times. The introduction of an online appointment system drastically reduces wait times, optimize patient flow, and improves the general standard of care for patients. Hospitals can increase staff productivity, raise patient happiness, and ultimately improve medical out comes by cutting wait times. Without such a system, hospitals could find it difficult to meet patient demand, which might lead to longer wait times, worse patient satisfaction, and a reduction in the number of patients seen.

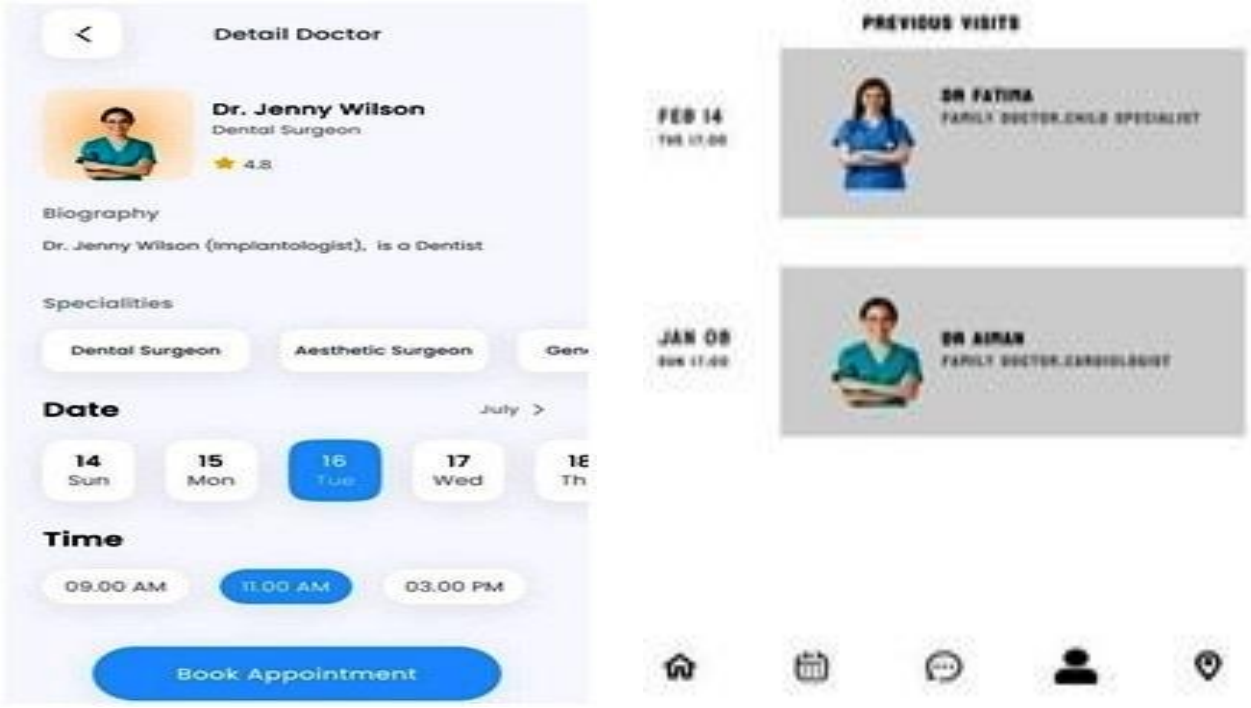

Fig.13. Mobile Application interfaces for booking appointment

Application Interface: In order to give consumers, the ability to easily manage their appointments, including booking, amending, and canceling them, we have meticulously created a suite of application interfaces. These user interfaces offer a comprehensive solution for appointment administration in hospitals by accommodating a wide range of consumer requests.

Conclusion: The value of time is recognized by both customers and organizations, regardless of their size or ownership structure, as time lost cannot be recovered or substituted. In particular, in healthcare settings, prompt access to medical services is of paramount importance to the health and well-being of patients, thus highlighting the significance ofoptimizing the use of time for both healthcare providers and patients. From the forementioned results, we can conclude that the registration queue and waiting room arethe bottlenecks in the process because the patients have to wait for indefinite amountoftimethusincreasingnumberofpatientsinqueueand slowingdowntheseprocesses.Ithasbeendemonstratedthato neofthemostcrucialcomponentsinraisingtheefficacyandeff iciencyofhospitalsinmanagingpatientsissimulatingtheproc essandadoptingBPRapproach.Itwasalsoobservedthatbyint roducingtheonlineappointmentthrougha mobile application, these bottlenecks can be bypassed and the patient flow can beoptimized and the total time spend in the process can be reduced. Overall, the implementation of online appointment booking via mobile app has the potential to greatlyimprovethepatientexperienceandhelptoreducethelo ngwaitingtimesthatareoftenassociated withhospitalvisits.

REFERENCES

[1] D. Chandra, "Reducing Waiting Time of Outdoor Patients in Hospitals Using DifferentTypesofModels:ASystematicSurvey,"*IJARI*,vol. 3,no.1,pp. 1–10, 2015, doi:10.51976/ijari.311501.

[2] S.Arshad,H.Waris,M.Ismail,andA.Naseer,"HealthCareSysteminPakistan:Areview," *RPHS*,vol.2,no.3,pp.211–216,Aug.2016,doi:10.32463/rphs.2016.v02i03.41.

[3] P.O'NeillandA.S.Sohal,"BusinessProcessReengineeringAreviewofrecentliterature,"*Technovation*,vol.19,no.9,pp.571–581,Sep.1999,doi:10.1016/S0166-4972(99)000590.

[4] T.A. Kochan and M. Useem, "Achieving Systemic Organizational Change".

[5] A. Patwardhan and D. Patwardhan, "Business process re-engineering – saviour or just another fad?:One UK healthcare perspective, "*International Journal of Health Care Quality Assurance*, vol.21,no.3,pp.289–296, May 2008, doi:10.1108/09526860810868229.

[6] A. Kumar and S. J. Shim, "Eliminating emergency department wait by BPR implementation," in *2007 IEEE International*

Conference on Industrial Engineering and EngineeringManagement,Singapore:IEEE,Dec.2007,pp.1679–1683.doi:10.1109/IEEM.2007.4419478.

[11] M. Bliemel and K. Hassanein, "E-health: applying business process reengineering principlestohealthcareinCanada,"IJEB,vol.2,no.6,p.625,2004,doi:10.1504/IJEB.2004.006129.

[12] S.Khodambashi,"BusinessProcessRe-engineeringApplicationinHealthcareinaRelationto Health Information Systems," Procedia Technology, vol. 9, pp. 949–957, 2013, doi:10.1016/j.protcy.2013.12.106.

[13] J. C. Woodall, T. Gosselin, A. Boswell, M. Murr, and B. T. Denton, "Improving PatientAccesstoChemotherapyTreatmentatDuke CancerInstitute,"Interfaces,vol.43,no.5,pp.449–461,Oct.2013,doi:10.1287/inte.2013.0695.

[14] [10]"_.pdf."

[15] K. A. Klafehn, "Impact points in patient flows through a radiology department providedthrough simulation," in Proceedings of the 19th conference on Winter simulation WSC'87, Atlanta, Georgia, United States: ACM Press, 1987, pp.914–918.doi:10.1145/318371.318715.

[16] M. A. Ortiz and P. López-Meza, "Using Computer Simulation to Improve Patient Flow atanOutpatientInternalMedicineDepartment,"in *UbiquitousComputingandAmbientIntelligence*, C. R. García, P. Caballero-Gil, M. Burmester, and A. Quesada-Arencibia, Eds., inLecture Notes in Computer Science, vol. 10069. Cham: Springer International Publishing,2016,pp. 294–299. doi:10.1007/978-3-319-48746-5_30.

[17] J.Sun*etal.*,"ReducingwaitingtimeandraisingoutpatientsatisfactioninaChinesepublictertiary general hospital-an interrupted time series study," *BMC Public Health*, vol. 17, no.1,p. 668, Aug.2017,doi:10.1186/s12889-017-4667-z.

[18] J. Idialu, "BUSINESS PROCESS RE-ENGINEERING PERFORMANCE OF NIGERIAHEALTHPERCEPTION ON WAITINGTIME".

[19] S.R.MahardiniandM.Dachyar,"TheCriticalImprovementofHospitalClaimFulfillmenttowards Public Insurance, using BPR and MIS Approach," in *2020 3rd International Conference on Applied Engineering (ICAE)*, Batam, Indonesia: IEEE, Oct. 2020, pp. 1–6. doi:10.1109/ICAE50557.2020.9350551.

[20] J. Rowley, "Designing and using research questionnaires," *Management Research Review*,vol.37,no.3,pp.308–330, Mar.2014,doi:10.1108/MRR-02-2013-0027.

[21] J. W. Jones *et al.*, "The DSSAT cropping system model," *European Journal of Agronomy*,vol.18,no.3–4,pp.235–265, Jan.2003, doi:10.1016/S1161-0301(02)00107-7.

[22] J.J.O'Reilly,K.C.Nordlund,andP.Corporation,"INTRODUCTIONTOSLAMPIANDSLAMSYSTEM".

[23] J. M. Farrar, S. M. Abou Rizk, and X. Mao, "Generic Implementation of Lean Concepts inSimulation Models,"vol. 1, 2004.

[24] I. Motola, L. A. Devine, H. S. Chung, J. E. Sullivan, and S. B. Issenberg, "Simulation in healthcare education: A best evidence practical guide. AMEE Guide No. 82," *MedicalTeacher*,vol.35,no.10,pp.e1511–e1530,Oct.2013,doi:10.3109/0142159X.2013.818632.

[25] M.H.Jansen-VullersandH.A.Reijers,"BusinessProcessRedesignataMentalHealthcareInstitute:".

[26] G.AagesenandJ.Krogstie,"AnalysisandDesignofBusinessProcessesUsingBPMN,"in*Handbook on Business Process Management 1*, J. vomBrocke and M. Rosemann, Eds.,Berlin, Heidelberg: Springer Berlin Heidelberg, 2010, pp. 213–235. doi: 10.1007/978-3642-00416-2_10.

[27] L. B. Russell, Y. Ibuka, and D. Carr, "How Much Time Do Patients Spend on OutpatientVisits?: The American Time Use Survey," *The Patient: Patient-Centered Outcomes Research*,vol.1,no.3,pp.211–222,Jul.2008, doi:10.2165/1312067-200801030-00008.

[28] Abbas,G. et al., 2022. prospects and challenges of adopting and implementing smart technologies in poultry production. Pak. J. Sci, 4(2): 108.