ARTICLE

IMPROVEMENT OF PATIENT PATHWAY IN A BREAST CANCER CENTER

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ABSTRACT

The aim of this paper is to establish the patient flow diagram of a breast cancer center in a private hospital in Turkey and to decrease the current waiting time of patients by applying specific scenarios. With the help of the patient flow diagram and practices applied, the model is to increase the degree of welfare of patients and hospital personnel, to ensure that the resources are efficiently and effectively used, as well as minimizing the financial loss by decreasing the idle time spent in unnecessary queues. The patient flow diagram of the breast cancer center is modeled by means of commercial software ARENA. Discrete event simulations in ARENA are performed by using recorded data to find bottleneck of the system. Patients' queues are chosen as performance criteria. Various scenarios are derived to obtain a significant decrease of waiting time. The results showed that most of the performance criteria gave a significant difference compared to the actual situation whereas some of them are insignificant. Finally, the scenario, which gave the highest improvement, was chosen as the critical improvement scenario for the breast cancer center patient flow system. The increased demand versus insufficient sources caused in healthcare services due to poor quality with long queues during the diagnosis and treatment process, collection of data was the biggest challenge faced during observation. This model can only be used if adapted to processes of other cancer types, other breast cancer centers or any other unit in a hospital. This paper is giving an example of a current and future value stream map showing step by step where the bottlenecks are and how it can be improved and what specific benefits it will bring to the healthcare system specifically to breast center. It will be useful for both academicians and practitioners on how to apply lean to healthcare.

KEY WORDS
Arena, Simulation, Breast Cancer Center, Patient Flow Diagram

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INTRODUCTION

Nowadays due to high population and scarce resources, waiting in queues is inevitable. Queues are seen almost everywhere such as at supermarkets, banks, universities, and hospitals. In this sense, it can be said that queues have become a part of our life. However, waiting in queues is causing unsatisfied customers, which also results in loss of customers. More importantly, queues are resulting in vital consequences. When queues in healthcare are concerned, the degree of illness may increase with the time spent in queues and even may cause death. Therefore, organizations must provide their patients a systematic health service. An effective service includes serving the patients as soon as possible with a higher quality as well as employing enough number of employees. When the optimum numbers are determined, patients will not be waiting in queues too much and costs of unnecessary employees will be decreased. Hospitals are the most distinct places of queuing problems. Most patients are waiting in queues to be examined while others are waiting in queues to have inpatient treatment or to undergo surgery [1]. Another problem foreseen in hospitals is that even though there is a huge queue of patients (most of the time causing confluence) equipment/physician/nurse are kept idle. Because of this, patients are wasting their time in queues as well as resources are not being used efficiently.

Patient flow diagrams are prescriptive diagrams be synchronizing resource, employee and patient to use resources more efficiently (decreasing the waiting time in queues) by showing step by step where patients are supposed to go, the average time of each step, intradepartmental flow time, bottlenecks in the system.

The aim of this paper is to establish the patient flow diagram of a breast cancer centre in a private hospital in Turkey and to decrease the current waiting time of patients by applying specific scenarios. With the help of the patient flow diagram and practices applied, the model is expected to increase the degree of welfare of patients and hospital personnel, to ensure that the resources are efficiently and effectively used, as well as minimizing the financial loss by decreasing the idle time spent in unnecessary queues.

LITERATURE REVIEW

Queuing system

Queues or waiting lines help facilities or businesses provide service in an orderly fashion. As defined by Baht [2] queuing theory embodies the full gamut of such models covering all perceivable systems that incorporate characteristics of a queue.

The history of queuing theory goes back 100 years. Johannsen's "Waiting times and number of calls" (an article published in 1907 and reprinted in Post Office Electrical Engineers Journal, London, October 1910) seems to be the first paper on the subject [2]. On the other hand, Erlang's work "the theory of probabilities and telephone conversations" and the studies done by Molina in 1927 and Fry in 1928 has been motivation for having the practical problem of congestion [2]. In addition Crommelin, Pollaczek, Khintchine, Kolomogorovv and Palm have done research related to this topic [3].

This system was used only in telecommunication industry until the 1950's; afterwards it was widely spread to other industries. It has been used in designing the traffic flow (including both human beings and cars), scheduling (patients in hospitals, jobs assigned to machines, programs in a computer) and banking sector. Pollaczek, Sysoski, Saaty, Bhat and Taha are academicians who have studied under this major.
Queuing system is defined as customer incoming to the system to receive service, and if not urgent wait in the queue and if waited should leave the system as being served [4]. According to this definition, patients who come to the hospital to be served must leave the hospital after being served.

On the other hand queuing discipline, is explaining whether if the customer should be waiting or not in the queue or if have waited in the queue for a time and then left it without receiving the service [5]. Sundarapandian also added that if the incoming customer were above the service capacity of the system then for sure there would be a queue. If there is a queue, the decision of waiting in the queue is completely the customers desire [5].

Constraints theory

Constraint is an element, which decreases the systems performance. The objective is to use this constraint in the best way in order to reach the highest productivity. Considering a system, first it has to be divided into subsystems and be analyzed. The product, which is going to be produced in this system, will be produced altogether by the subsystems and the slowest subsystem will determine the speed of the system. It does not matter how fast the other subsystems are but the result will not change if the slowest subsystem does not speed up. The slowest subsystem is causing a bottleneck, which is playing a determining role in the speed of the system [6].

Queuing systems applied in healthcare industry

Queuing models are used to receive information on each task in healthcare systems and to figure out the causes of mistakes or errors based on patient care or caring processes. On the other hand, it is also used to improve the general system performance and to estimate the unfavorable tendencies and the consequences of the decisions taken.

Being directly related to human life the healthcare industry is accepted to be different than others and due to it complicacy of its system it is presenting a vital importance to the subject. When the literature is analyzed, more specifically it is seen that between the years 1993 and 2012 there is a cumulative increase in research related to order theory and healthcare industry. Twenty five percent of the research analyzed between these years are related with emergency rooms, twenty-three percent used order theory to analyze the whole hospital generally. Fourteen percent of the research was done on the waiting time of outpatient care and patient satisfaction. Nine percent on operating rooms, seven percent on cardiac surgery, seven percent on patient transportation, another seven percent on assigning beds to inpatients, two percent on accident immediate care, two percent on endoscopy, and the rest two percent of the research was done on the front line assembly area [7]. Research other than these include topics such as queuing theory waiting time, sourcing, systems design, appointment system, system analysis, patient scheduling, resource scheduling and ambulance service.

Varieties of solutions were analyzed for different healthcare organizations including outpatient care centers, hospitals or organizations including both. Quantity oriented research such as, optimizing the number of beds in a hospital or quality oriented research, such as, distributing ambulances for gaining a balanced access were done. Patient waiting time is an important performance criterion for ambulance systems. Bell and Allen in 1992, did research related with multi-server queuing models to be able to reach the predetermined response rate [8]. In healthcare systems on time, access to care became an indicator for a high quality healthcare service. Various researches were done in outpatient clinics, surgical operations, gynecology and newborn unit and mental health units.

Bretthauer et al., has analyzed the blocking of units with a heuristic approach as patients moved from one unit to another and as patients completing their first care in the first unit could not pass to the next due to the inadequate capacity of the second unit [9].

Bailey has mentioned on individual-blocking system by determining two variables, which are determining the effectiveness of the appointment system according to appointment range and the arriving time of the physician [10]. Ho and Lau has mentioned about appointment systems with variable ranges [11].
Waiting time utilization and cost minimization together with longitude of queues are mentioned in healthcare systems analysis.

In a queuing system customers (patients for healthcare systems) minimizing the waiting time and maximizing utilization of server and resources (physician, nurse, beds for healthcare system) are expected. Especially patients leaving the queue without receiving the service has been analyzed to be a very important performance rating parameter in hospital emergency units [12]. Increasing the service capacity which is a traditional method, has a very little effect on reducing the long queues because when patients realize that their waiting time is going to decrease the will increase their speed of incoming to the unit which in fact will result in an increase in the length of the queue once again [13]

Information on cancer centers

Due to the increase in the number of cancer patients, the need of cancer centers are increasing cumulatively. Therefore, the number of cancer centers must increase as well as the current centers must be improved in order to serve better in the world and of course in Turkey. Patient waiting times are increasing, as demand is high when looked from the patients' perspective. When analyzed from the service provider perspective, improved processes would result in higher patient flow as well as higher profit. Unfortunately, it is quite hard to improve the cancer center processes due to high patient numbers, multi-stage service care, uncertain daily demand and uncertain patient floe diagrams.

Modelling by simulation

Simulation is taking a real system as a base and designing a model of this system and analyzing the behavior of the system or is the total of all the strategies applied to improve the system. Simulation started to be properly used in the 1990's. Good animations, ease of use, high speed of computers, and ease of application of other packages made simulation a standard tool in many organizations [14].

Using simulation in cancer centers

The first objective of healthcare services is to provide health but the demand is uncertain and variable. Therefore, using simulation model, without harming or occupying any resource, possible changes can be made and analyzed.

In 2009, Santibanez has analyzed an ambulatory care unit (ACU) of the British Columbia Cancer Agency (BCCA) in Vancouver. In this research, any change done on the physical infrastructure, planning politics and assignment of capacity, which is effecting the patient waiting time, overtime in the clinic and sourcing were analyzed. It was found that changing or improving more than one variable would give the best result, in which, patient waiting time decreased by 70%, need for physical area (size of care room, number of rooms, infrastructure, physician working area, and patient waiting area) has decreased by 25% [15].
Changing the laboratory and pharmacy locations and making changes in the planning procedures has justified 30% increase in rate of patient checking out with the application of simulation [16].
In another research done in Louisville, six different scenarios were formed and compared with current situation. Some of the scenarios were as adding two specialized nurses such as specific breast nurses for the breast cancer center.[17]

The aim of this paper is to establish the patient flow diagram of a breast cancer center in a private hospital in Turkey and to decrease the current waiting time of patients by applying specific scenarios. With the help of the patient flow diagram and practices applied, the model is expected to increase the degree of welfare of patients and hospital personnel, to ensure that the resources are efficiently and effectively used, as well as minimizing the financial loss by decreasing the idle time spent in unnecessary queues it has been decided to analyze breast cancer centers in Turkey as breast cancer is the most common cancer type faced in Turkey nowadays. Simulation will be used as the first step of the study to figure out the main problem of the centers.

METHODS

The literature review and observation showed that patients are mostly suffering from waiting in the queue. So the aim of this paper as mentioned before is to minimize the waiting process and improve healthcare services in breast cancer centers in Turkey. In this study, as the state variables are differentiating in some points (patient entering the hospital or patients after being served) discrete event simulation has been used.

In order to detail the process, expert opinion was taken. Therefore breast surgeon, radiologist, pathologist; pathology technician, radiology technician and desk nurse were interviewed in the chosen private university hospital. Both open and close-ended question were asked during the interview. With the help of these questions, the process of the system and the physician schedule was learned in detail. In addition to this observation was also done. For this, the researchers were present at different departments in the hospital. Time spent in each machine, and time of examination were measured by a stopwatch and collected. Collection of information took place between 10 March 2014 and 08 April 2014, in a one-month observation period.

ARENA simulation program was used to draw the patient flow diagram and after analyzing the data distribution, it was added to the diagram, which was formed by the simulation program ARENA.
The case study was decided to be done in a private university hospital in Istanbul Turkey. The hospital is giving service between 08:00 until 17:00. However, starting from 16:50 no patient registration is done. In addition to this even though the hour of work is finished if there is a patient in a machine or in a physician's room being examined, the extra time spent is accepted as overtime. The workday finishes when the last patient is discharged from the clinic.

Between 12:00-12:59, the hospital has lunch break and apart from the operations room and emergency room the rest of the departments are not working during the lunch break. There is only one breast surgeon in this hospital. Every hour five patient is visiting the general surgery department. Patients visiting the breast surgeon are 25% of the total patients visiting the general surgeons.

Patients are visiting the hospital via appointments taken from internet or telephone. After patient enters the hospital, they have to make registration and then be examined by the surgeon. This is a manual examination done in the surgeon room. During this time, surgeons listen to history of patients. After the manual examination if the surgeon decides that there is nothing going wrong the patient is discharged. In other cases patient is sent to the radiology unit for imaging processes. Patients' age is important at this point, being above or below age forty makes sense. Patients below age forty are only asked to have ultrasound examination. For patients at age forty or above only ultrasound or both ultrasound and mammography may be requested. [Fig. 1] is showing the present system of the private university breast cancer center.

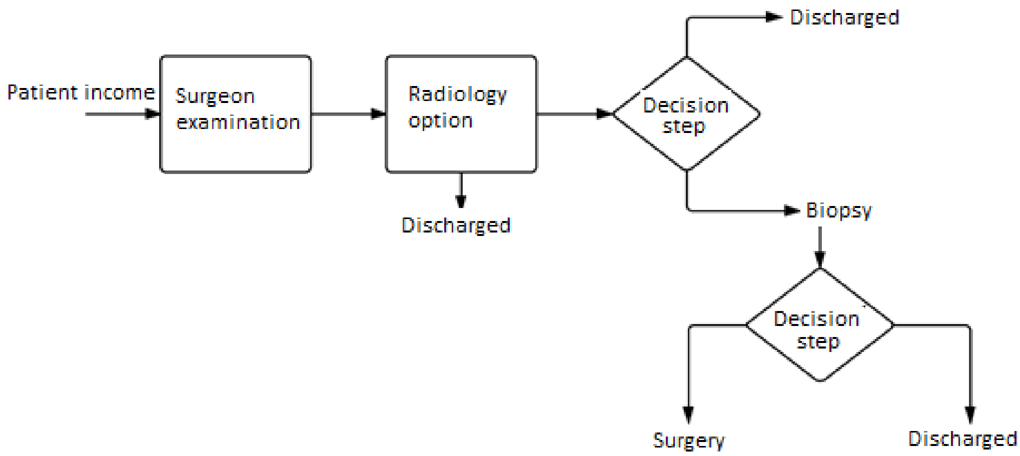

Fig. 1: Present system of breast cancer centre

The patient first has to be registered at the radiology department and manual examination is done by the radiologist. The ultrasound is done by the physician by the mammography is taken by the technician. The results of the ultrasound and mammography are not printed and given to the patient immediately but are directly seen at the computer screen of the surgeon. The surgeon loudly examines the results of the ultrasound and/or mammography and saves the voice as a voice message. Then the reporter transfers the voice message in a written document and prints it. For both of the results the patient is called one day after the examination is done to pick up the results. If there is no need for biopsy the patient is discharged. If biopsy is requested, it is done immediately and after the biopsy operation, the patient is sent home. The piece taken from biopsy is sent to the pathology department. The results from the pathology department finalizes in three to four days. Patient comes to the hospital to take the results, if not ready this action is repeated. After all the results are ready, the breast surgeon analyses them and decides whether MRI is needed. MRI is an imaging system taken by a technician. MRI results are ready in 24 hours. At the end the breast surgeon decides whether if the patient needs operation or not by examining the MRI results or pathology results or both. If operation is not needed the patient is discharged with a decision of close follow-up.

Finally, the model is operated and the time of queues and patient time spent in each unit is determined. For system improvement, more than one scenario is developed and analyzed afterwards. Each patient flow diagram for each unit is shown in supplement figure A1 to A10 in detail.

RESULTS

Data was collected in a one-month period between 10 March 2014 and 08 April 2014. As explained before the observed hospital is giving service between 08:00 until 17:00. However, starting from 16:50 no patient registration is done. In addition to this even though the hour of work is finished if there is a patient in a machine or in a physician's room being examined, the extra time spent is accepted as overtime. The workday finishes when the last patient is discharged from the clinic. Between 12:00-12:59, the hospital has lunch break and apart from the operations room and emergency room the rest of the departments are not working during the lunch break.

Appointments are arranged in a range of one hour for each appointment. Excel Easy Fit determines the distribution of the collected data. The distribution was found to be Poisson distribution (λ=40 patient per day). After determining the distribution by Excel Easy Fit it was statistically tested and proved that Poisson distribution is best fitting the data distribution.

There are four general surgeons employed in this hospital and 25% of the patients visiting surgeons belong to breast surgery. 0.2% of the patients visiting the breast surgeon are having biopsy and 0.07% is having a surgical operation.

The patient flow diagrams are shown in Appendix from figure A1 to A10 at the end of the paper.
The system was calculated ten times (number of replications) in thirty days (replication length). Patient flow was also observed in the system. The processes in the system were either observed or referred to an expert opinion. The following table [Table1] is giving information on the distribution parameters (in minutes) for each task in the process.

Table 1: Distribution types for healthcare process in breast cancer centre

Task	Used Resource	Distribution Type	Distribution Parameters
Hospital Registration	Desk Staff	Constant Dist.	2 (min)
Physical examination	Breast Surgeon	Normal Dist.	15-20 (min)
Radiology registration	Radiologist desk staff	Normal Dist.	2-3 (min)
Physical examination	Radiologist	Constant Dist.	1 (min)
Breast Ultrasound	Radiologist	Normal Dist.	14-16 (min)
Mammography	Technician	Normal Dist.	15-20 (min)
Ultrasound reporting	Radiologist	Normal Dist.	1,8-2,2 (min)
Mammography reporting	Radiologist	Normal Dist.	1,8-2,2 (min)
Reporting	Reporter	Constant Dist.	4 (min)
Consultation	Breast Surgeon and Radiologist	Normal Dist.	5-8 (min)
Biopsy	Radiologist	Normal Dist.	20-25 (min)
Breast MRI	Technician	Normal Dist.	20-30 (min)
MRI Evaluation	Radiologist	Constant Dist.	3 (min)
MRI Reporting	Radiologist	Constant Dist.	2 (min)
Pathology	Technician and pathologist	Normal Dist.	3-4 (min)
Outcome evaluation	Breast Surgeon	Normal Dist.	4,8-5,2 (min)
Examination after MRI	Breast Surgeon	Normal Dist.	4-6 (min)
Surgical operation	Breast Surgeon	Normal Dist.	1-1,5 (hrs)
Other processes	Breast Surgeon	Normal Dist.	20-25 (min)
Breast Surgeon other consultation	Breast Surgeon and other doctor	Normal Dist.	5-8 (min)
Radiology other registration	Radiologist desk staff	Normal Dist.	2-3 (min)
Radiology other processes	Radiologist	Normal Dist.	5-8 (min)
Radiology other consultation	Radiologist and other doctor	Constant Dist.	10 (min)
Radiology other ultrasound	Radiologist	Normal Dist.	14-16 (min)
Radiology other processes	Technician	Normal Dist.	15-20 (min)

Visits to the surgeons have been determined to be Poisson distribution. As breast patients visiting the surgeons are a sample of the patient population it is accepted that they are also fitting the Poisson distribution. Addition to fitting the Poisson distribution there may still be patients visiting surgeons in other specific hours. Visiting distribution is developed by ARENA program.

Patient registration process has a standard value and takes two minutes. This process is done by Decision module and can have two or more alternatives and each alternatives percentage is added to the system.
In order not to reject the patients, visiting the hospital at lunch break a Hold module is used and patients set to wait until the break is over. In this study, human flow is analyzed. In addition to this in order to be able to receive blood tests and radiological examination workflows must be also considered together with human flows. For this reason, workflow is paralleled added to human flow and is determined to have both of them at the same time. The Separate module is used for this situation. Batch module is used to pair two

entities. As an example batch module is pairing the patients report outcomes and patient next visit to the hospital. By this module, when report outcomes are not ready the patient goes back home, but if report outcomes are ready then the system continuous with the next step in the flow chart. Record module is keeping records of the time spent between the requested modules. At the point where patients care is finished the Dispose module is the module used to discharge the patients from the system.
After all the data are transferred to the program, the program is operated ten times in thirty days. The length of the queues can be obtained as well as by placing assign and record modules to intervals, which are requested to be measured, are also possible.

Nine performance criteria were selected. These nine criteria are (1)discharged patients from first surgeon examination, (2)MRI and USG report extra waiting time, (3)patient coming to radiology department but not having biopsy operation and being discharged, (4) discharged patient after all examinations are done but without having a surgical operation, (5)biopsy process, (6)surgeon physical examination, (7)second step physical examination (radiologist physical examination), (8) surgeon and radiologist consultation, and (9) breast surgeon outcome assessment. The current situation performance measurement is shown below in [Table 2].

Table 2: Current situation performance measurement

Perf. Crit.	Ave.	Half Credible Intervals	Min. Ave.	Max. Ave.	Min. Value	Max. Value
1	1,647	0,37	0,87	2,35	0,28	20,83
2	0,66	0,48	0,00	6,54	0,00	99,67
3	30,15	1,93	27,55	36,78	24,61	141,41
4	123,71	3,71	117,91	136,01	102,16	190,53
5	0,25	0,13	0,058	0,78	0,00	1,15
6	1,26	0,32	0,68	1,95	0,00	21,65
7	0,41	0,45	0,09	2,17	0,00	20,65
8	4,13	2,26	1,34	11,04	0,00	115,75
9	2,35	0,75	0,80	4,82	0,00	8,43

According to the performance criteria mentioned above, average time spent until discharge is that patient being discharged after just being examined by the surgeon take 1.6hrs. The minimum waiting time of a patient after entering the hospital is 0.28 hrs or in other words 17 minutes, maximum waiting time of patient until being discharged is 20.83 hrs. Averagely a patient is discharged with a delay of average minimum 0.88 hrs. (53 min.) and maximum average rate is 2.4 hrs.

Normally the outcome of MRI and USG are being prepared in one day after the examination, but the average delay of it reaching the patient is 0.66hrs (40min.). As the report delivery minimum delay is 0 hrs, maximum waiting time is 99 hrs. (4 days). Averagely it is minimum zero hrs. and maximum average delay is 6.5 hrs.

Patient going to radiology department but no need to have biopsy operation is discharged starting from his/her entrance to the hospital in 30.2 hrs. (1.3 days). Minimum waiting time of patient is 24.6 hrs. and maximum waiting time is 141 hrs. (5.9 days). Averagely waiting time is minimum 27.6 hrs. (1.2 days), and maximum average is 36.8hrs (1.5days) until the patient is discharged from the radiology department.
For patients after having a biopsy operation but no need to have surgical operation are discharged with an average of 123.7 hrs. (5.1days). Minimum time to be discharged is 102 hrs. (4 days), maximum time to be discharged is 190 hrs. (7.9 days). Averagely min 118 hrs. (5 days) and maximum average is 136 hrs. (5.7 days) for the patient to be discharged.

Alternative scenario's for system improvement

After forming the model for the current situation, the system is recommending different scenarios for the improvement of various performance criteria.

Scenario 1

The latest time for accepting patients has been changed from 16:50 to 16:00. Correspondingly, important changes have been seen in many ranges and queues. With this change, even though not much difference was seen with the surgeon first examination average time, the maximum waiting time (20.8303 hrs.) has been decreased and became the lowest time (5.2685 hrs.). Waiting time for MRI and USG reports has dropped by 10% when compared to the current situation. All these differences were tested with ANOVA test to make sure they were significant. This test had 95% confidence level. When $p<0.05$, it means that two scenarios are significant. Therefore, instead of comparing the current situation and scenario, the p values, which are less than 0.05, have been taken into consideration for determining the criteria. ANOVA test for Scenario 1 is significant and queues of performance criteria 1, 5 and 6 have shown improvement.

Scenario 2

In the second scenario, resource numbers were changed to see how it affects patient queues. Number of radiologist has been increased from 1 to 4, and technician number has been increased from 7 to 8. Queues of performance criteria 1, 2, 3, 5, 6, 8 and 9 have shown improvement as the waiting time of patients has decreased. However, when ANOVA test was calculated the only improvement was seen in the queue of the fifth performance criteria.

Scenario 3

In the third scenario once again resource number differences has been tested. However, this time the number of breast surgeon has been increased from 1 to 2 breast surgeon. With this increase queues at 1, 2, 3, 4, 6, 8, and 9 performance criteria has shown improvement. However, not all of them were statistically significant. The statistically significant ones were 1, 3, 6 and 8 performance criteria queues.

Scenario 4

In this scenario, a different type of resource has been changed. This time the number of USG machines has been increased from 1 to 2, and its effect was checked. With this additional machine queues at performance criteria 1, 2, 3, 4, 5, 6, 7, and 8 (almost all) has showed improvement. Statistically significant ones were found to be the queues of 5 and 7 performance criteria.

CONCLUSIONS AND RECOMMENDATIONS

Even though the rate of having cancer in Turkey is increasing progressively, studies done for improving the process of patients waiting time is limited. Especially there is no single research done for forming patient flow diagrams, simulating them and determining the bottlenecks in order to improve the process of Breast Cancer Centers. In this respect, this paper is the primary research done in Turkey. This study was applied to a private university hospital in Istanbul at its breast cancer center. The patient flow process has been analyzed. Besides, various alternative scenarios were formed for improving the flow of patients through the center. As the model is too complicated, various acceptances were made. This study is the basis of patient flow diagram formation in breast cancer centers.

In this paper after the present system was analyzed, it was figured out that there is a build-up and workload density at the radiologists and at the breast surgeons. For decreasing the build-up and ensuring improvement four different scenarios were formed. Some of these scenarios included changing the number of resources used in the system and some of them intended to change the end of patient admission time. However, the improvement was not only based on decreasing the queue length but was expected to be statistically significant at the same time. For this reason, ANOVA significance test was applied.

In the first scenario, the latest patient admission time was changed from 16:50 to 16:00. By this way not only the work load of doctors were decreased but also patients coming to the hospital and waiting unnecessarily, and any idle time was tried to be prevented. In this case, the patients with no cancer suspicion who visit the breast surgeon mistakenly will be discharged earlier from the physical examination. On the other hand, a patient with its MRI and/or USG done earlier will spend less time in the physical examination room of the breast surgeon and the decision whether or not to have biopsy will be given in less time.

In the second scenario, the number of radiologists and radiology technician has been increased by 1. Therefore, only a patient who needs biopsy will have her/his biopsy in less time and as well by waiting less in the queue.

In the third scenario, the number of breast surgeons has been increased from one surgeon to two breast surgeons. By this way, the number of patient waiting in the queue in the present system has decreased with the new scenario. Patients with no cancer suspicion, visiting the breast surgeon mistakenly will be discharged from the physical examination earlier than before. Patients with their MRI and/or USG done before who also do not need biopsy will be discharged from the hospital earlier and that they will not wait unnecessarily as they do not need any treatment. In addition, these patients will not be waiting for days for the consultation of the surgeon and the radiologist, and will be discharged earlier from the physical examination of the breast surgeon. In the present state when the radiologist is idle the breast surgeon is either in physical examination or in a surgical operation. Because of this, a patient is forced to wait for the breast surgeon and radiologist consultation, which in reality takes only 5 minutes.
In the fourth and last scenario by adding one more USG machine to the system, the radiologist will do his/her physical examination and biopsy in less time.

Taking into account all of these scenarios, it is possible to reduce the workload of both breast surgeon and radiologist in the third scenario.

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As the data is not recorded in Turkey cancer centers and as alternative improvement scenarios are unlimited, this study is open to improvement in various subjects. For further recommendations, improvement in hospital process, improving more than one resource at the same time, cancelling lunch break are some other practicable scenarios.

This study is only considering the mentioned private university hospital, as other cancer patient flow processes show differences, this patient flow diagram cannot be generalized and used directly to any center. This model can only be used if adapted to processes of other cancer types, other breast cancer centers or any other unit in a hospital.

CONFLICT OF INTEREST

None

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Supplement Figures A1-A10: The development of patient flow diagrams

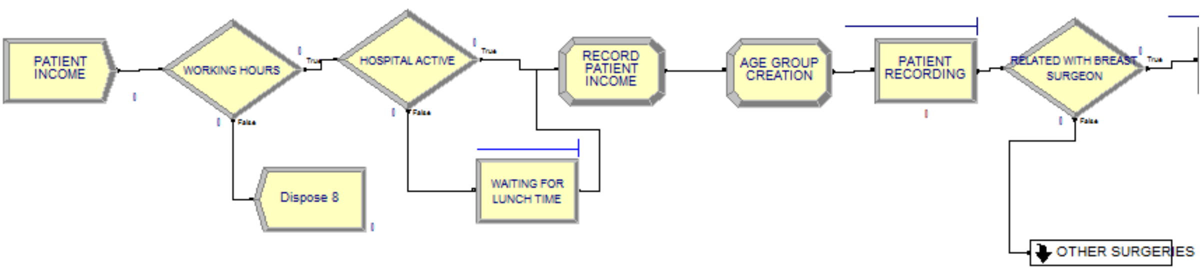

Fig. A1: Patient visiting surgeon

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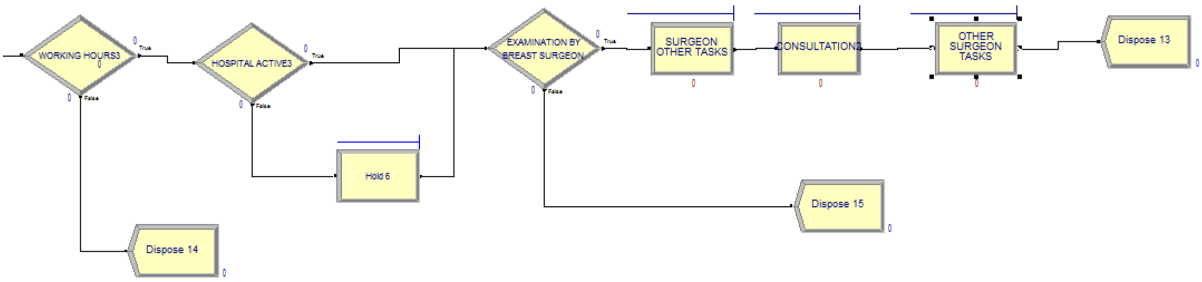

Fig. A2: Surgeon other tasks

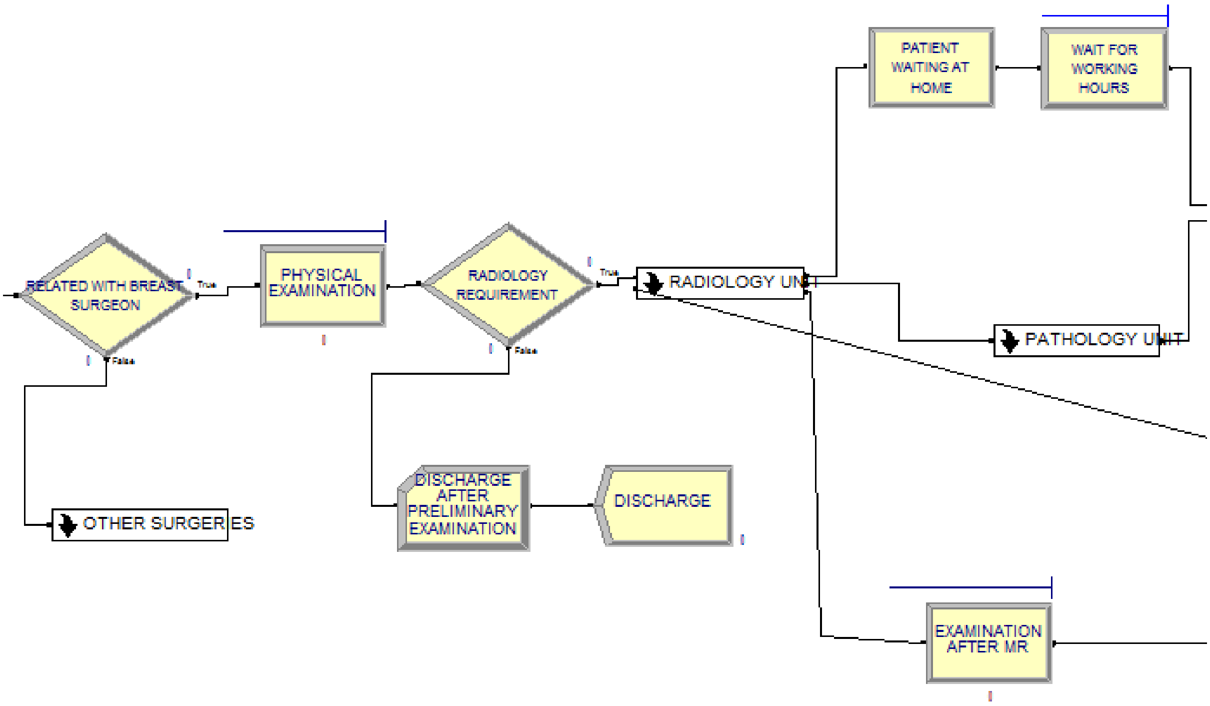

Fig. A3: Process between surgeon and pathology

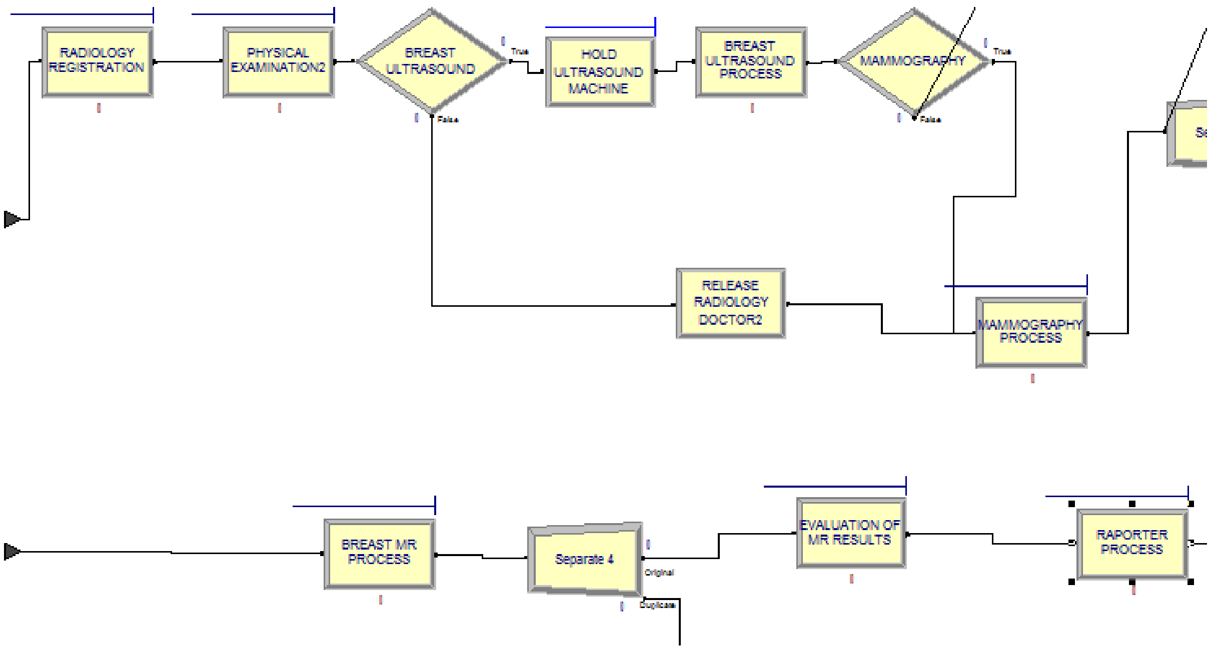

Fig. A4: Radiology Process 1

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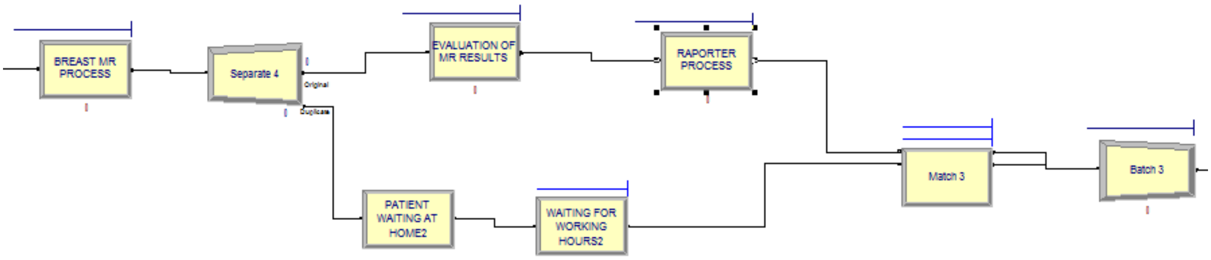

Fig. A5: Radiology process 2

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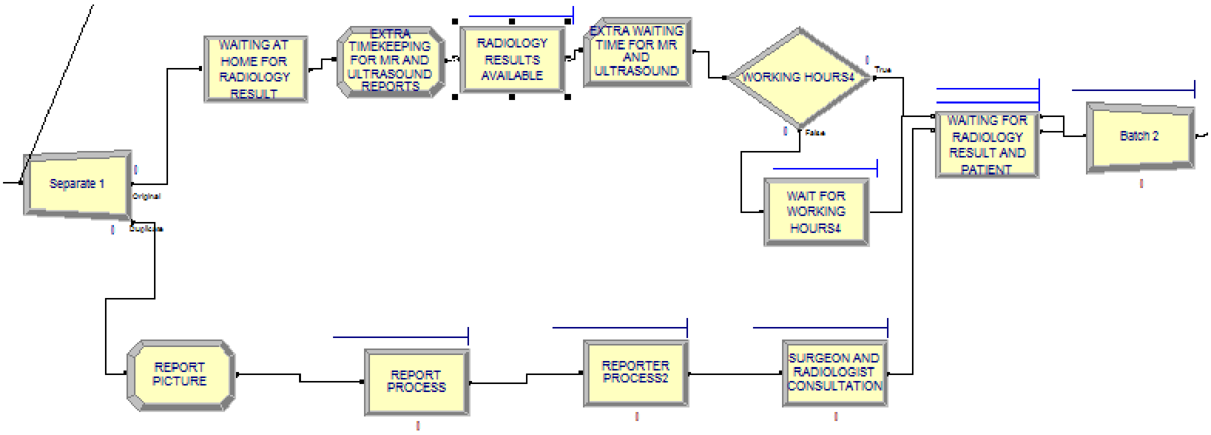

Fig. A6: Radiology process 3

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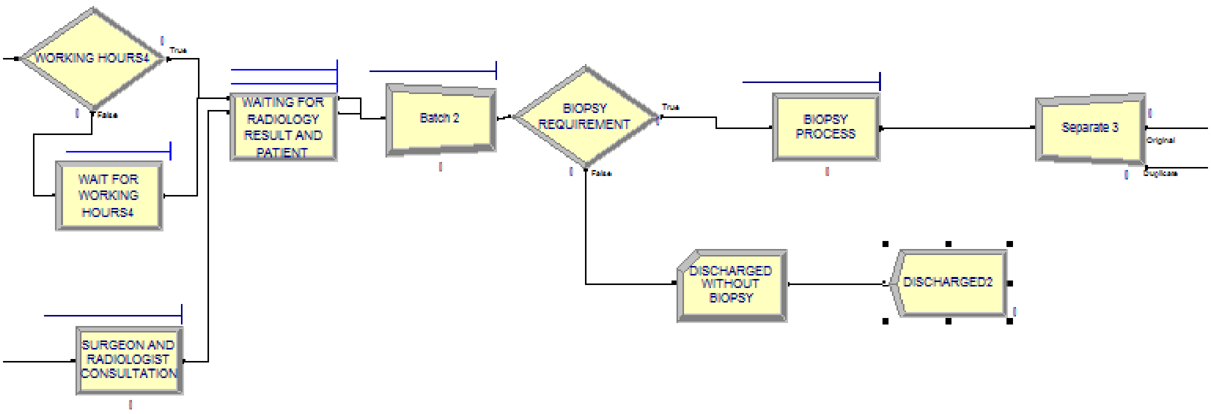

Fig. A7: Radiology process 4.

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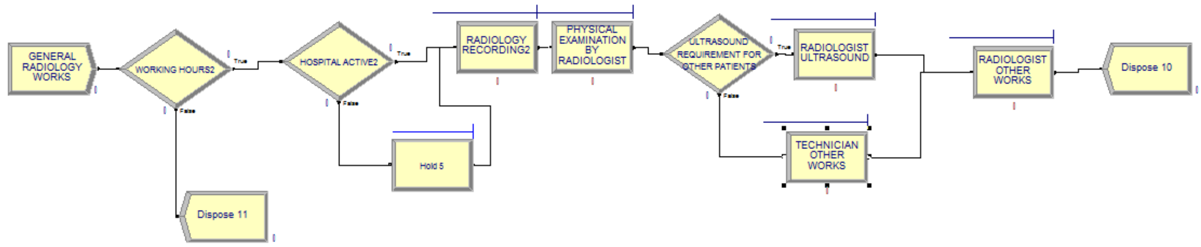

Fig. A8: Radiology other tasks

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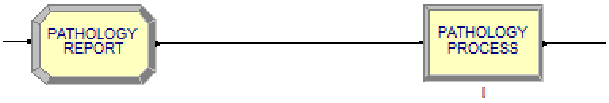

Fig. A9: Pathology tasks.

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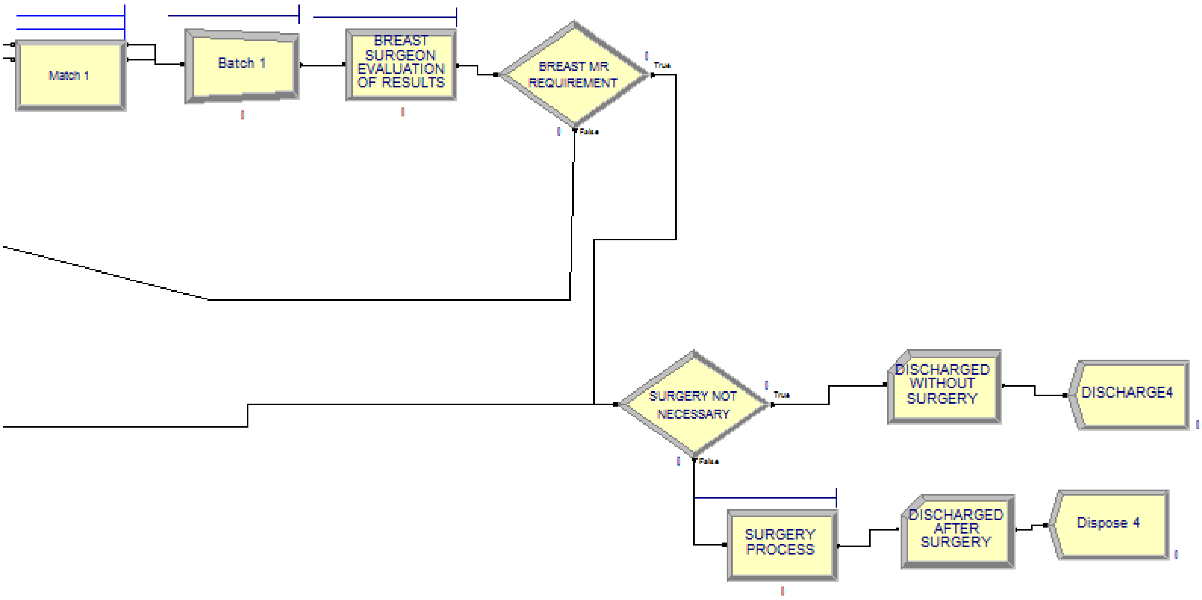

Fig. A10: Process after pathology

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