Advances in Social Science, Education and Humanities Research, volume 439
Tarumanagara International Conference on the Applications of Social Sciences and Humanities (TICASH 2019)

A Proposed Model for Outpatient Care Service Improvement Using the Healthcare Lean Approach and Simulation

Hafzoh Batubara
Industrial Engineering
Tanjungpura University
Pontianak, Indonesia
hafzoh12@gmail.com

Rifa Gandi Lesmana
Industrial Engineering
Tanjungpura University
Pontianak, Indonesia

Rini Dharmastiti
Industrial Engineering
Universitas Gadjah Mada
Yogyakarta, Indonesia
rini@ugm.ac.id

Muhammad Kusuma Herliansyah
Industrial Engineering
Universitas Gadjah Mada
Yogyakarta, Indonesia
herliansyah@ugm.ac.id

***Abstract*— The health service industry cannot be separated from the demands of quality, affordable, accessible, efficient and effective services. The Central Public Hospital of Dr. Sardjito, Yogyakarta, where the level of satisfaction of Outpatient Installation patients does not meet the minimum hospital service standards. The results of a real system simulation also prove that for 93.23% of the total time, the patient in the system isallocated waiting time for the service of around 4.82 hours. This proves that the patient's waiting time is still far below the hospital's minimum service standard. The high number of patients plus too many procedures to be undergone coupled with an overworked nursing entity results in long queues and bottlenecks. The purpose of this paper is to improve the patient care system through the Lean healthcare approach with a VSM tool, combined with modeling and a simulation system to observe changes from each alternative produced. Based on VSM analysis, three waste problems from each NVA and NNVA were obtained. From 6 simulated alternatives, one of the best alternatives obtained gave the highest total change in waiting time of all alternatives, with a total change of 73.16% from 4.822 hours to only 1.294 hours.**

Keywords: models, lean healthcare, VSM, waiting time, bottleneck, simulation

I. INTRODUCTION

Your The health care industry cannot be separated from cost challenges and quality services. Health services are challenged to be affordable, accessible, safe, thorough, efficient and cost- effective services [1]. According to Law No. 44 of 2009 [2], hospitals are health care institutions for the community with their own characteristics that are influenced by the development of health science, technological advances, and the socio-economic life of the people that must be able to improve quality and affordable services for the community to realize the highest degree of health. The law states that in order to improve the quality and coverage of hospital services and regulate the rights and obligations of the community in obtaining health services, it is necessary to regulate hospitals with laws. With this in mind, the government has set standards regarding the minimum limits compared to the Key Performance Indicators (KPI) that are measured to obtain better quality services in accordance with the law.

According to Parmenter [3], KPI are defined as a series of steps that focus on the aspects of organizational performance that are most important for current and future success. Data regarding the achievement of customer satisfaction levels per work unit of Central Public Hospitals (RSUP) in 2015 showed Dr. Sardjito Hospital,Yogyakarta cumulatively to be 81.09%. In the Business Strategic Plan (BSP) of RSUP Dr.Sardjito for the period 2015 - 2019, the standard of achieving customer / patient satisfaction level was more than, or equal to, 80% when the target in 2015 was 85%. The conclusion was that Dr. Sardjito had been able to achieve customer satisfaction levels in 2015 in accordance with BSP standards, but had not been able to reach the set targets. was more than 90% while customer satisfaction at Dr. Sardjito RSUP Yogyakarta for outpatient care in 2015 was 81.30%..

In addition, according to data, the achievement of the cumulative customer satisfaction level of Dr. Sardjito Hospital , Yogyakarta in 2015 saw a pattern of decreasing customer satisfaction occurring, especially in December 2015. This was contrary to Law Number 44 of 2009 [2] which aimed to improve the quality of service as well as minimum service standards of hospitals based on [3], therefore it became necessary to increase service performance in order to increase customer satisfaction and meet the minimum hospital service standards set by the health minister. One approach that can be used to improve service performance in the field of medical care is the Lean healthcare approach [5].

Ohno [6] defines Lean as a way of removing resources such as expenditure or extra time without adding any value to the method. ‘Ways to Eliminate Waste’ [7] is a basic principle in Lean manufacturing which can be adapted to health. One of the seven categories of waste

mentioned in his book is waiting (waste of time waiting) which is closely related to the term 'queueing'.

Gill [8] and mentions one of the main indicators in the quality of hospital services as being 'patient waiting time'. His research shows that reducing waiting times can increase patient satisfaction. Patients prefer hospital services with a high level of service, therefore services that have longer waiting times tend to be avoided [9],[10]. This is because a longer waiting time results in many losses experienced by a patient, in terms of time, health condition and costs [11], [12], [13] further describes the possible impact of long waiting times as increasing the risk of patient pain and causing socio- economic costs. [4], stipulates in its regulation that the waiting time for registration of outpatients should be a maximum of 60 minutes. However, based on a report on the results of a quality index assessment of health services in the regional VI division of Yogyakarta in 2015, it was stated that in reality, in Yogyakarta hospitals, more than 10% of patients had to wait more than 30 minutes for enrollment and 40% of patients were required to wait more than 30 minutes for an examination. This shows that the hospital queueing system in the Special Region of Yogyakarta (DIY) is currently unable to meet [4]. Furthermore, the results of a real system simulation at the Outpatient Internal Medicine Polyclinic (IMP) proved that 93.23% of the total time allocated to a patient is time spent waiting for service; around 4.82 hours.

Selection of Internal Medicine Polyclinic is based on the highest number of patients in the Internal Medicine Polyclinic system with the same registration place. IRJ RSUP Dr. Sardjito offers a variety of disease services according to the type of disease to be treated, this type of service is called the polyclinic. IRJ has 5 floors where services are located on the 1st, 2nd, 3rd and 4th floors, while 5th floor serves as the IRJ's administrative centre. Each floor has an independent polyclinic registration centre so that each patient will be directed to the patient registration floor where there is a polyclinic relevant to the patient's diagnosis. The high number of patients and registration procedures to be performed, coupled with an overburdened nursing entity, results in long queues and bottlenecks.

Queueing is a tedious procedure experienced by everyone, so work processes require speeding up in the services and manufacturing fields [14], [15] These activities cannot be separated from the queueing problems that occur in every area of a hospital, which is just one of the institutions engaged in the health services sector [16]. Therefore, a strategy that can improve the queueing system is needed [17]. At present, many studies in the health sector carry out various ways to improve service performance, especially when it comes to queueing, one of which can be achieved by implementing Lean healthcare into the service system.

The way to think, according to Lean, is to try to eliminate or reduce waste by eliminating Non Value Added (NVA) activities and by reducing as much as possible the emergence of NVA. The Lean principle helps in minimizing unnecessary costs, reducing waste and improving inefficient procedures [6]. The Lean principle began to be applied in service fields all over the world, including the health sector, at the beginning of 2000 [5]. Lean application tends to show greater ability in the health industry compared to other models [18]. Therefore in this study we will discuss the application of Lean healthcare to resolve the queuing system problems that occur in the Internal Medicine Polyclinic of RSUP Dr. Sardjito by reducing the total waiting time of patients in the polyclinic system.

II. RESEARCH METHOD

We The research analysis unit was the Internal Medicine Polyclinic for Outpatient Installation (IMP)at the Central General Hospital (RSUP) Dr. Sardjito with the object of the research being the queueing system. The analysis unit was chosen because the Internal Medicine Polyclinic had a large number of patients compared to other clinics and long patient waiting times, resulting in long queues. The queueing model at this clinic is the Multi Channel, Multi Phase System of queueing. The data collection process was carried out for two months and from the observation, inter-arrival time of the patients and doctor's examination time is obtained.

A. Research Tools

The tools used in this study are Microsoft Office Excel 2013, ProModel 9.3.0.2051, IBM SPSS Ver. 23.0.0.0, and Microsoft Visio 2016.2.1.1 Microsoft Office Excel 2013.

a. Microsoft Office Excel 2013

This software will be applied to recapitulate all data used in this study, data storage, data processing and calculation of data with various formulas. Microsoft Excel 2013 is also used to graph as data representation.

b. PROMODEL 9.3.0.2051

ProModel is a Windows-based simulation software that is used to simulate and analyze a system [19], [20]. ProModel provides a good combination of usage, flexibility and modeling a real system to make it look more realistic [15]; [21]; [22].

c. IBM SPSS VER. 23.0.0.0

Testing the normality of the number of arrivals of patients, time of service, time of retrieval and distribution of files, and the time of the doctor's servant uses SPSS Ver. 23.SPSS is a computer program designed to perform statistical processing. SPSS combines the ease of use like Microsoft Excel with its ability to carry out complex statistical analysis.

d. MICROSOFT VISIO 2016

Microsoft Visio is a software for designing value stream mapping charts, activity cycle diagrams and flowcharts that are made to be displayed in the results and discussion section.

B. Data collection

Data collection was done through direct observation at the research site, interviews with the hospital staff, and through the archives. The data needed are:

- Patient arrival time data
- Patient inter-arrival time data
- Patient service time data for each server
- Data on patient transfer time between facilities
- Data on file collection and distribution time
- Data on the number of patients in the Internal Medicine Polyclinic
- Data on the amount of resources in the Internal Medicine Polyclinic

The Value Stream Map (VSM) tool was used to find out in detail the state of the patient process flow [23]. VSM is a good starting point in Lean assessment because it describes the process flow to determine which steps add value to patient services or products delivered to customers, which are known as value-added (VA), non-value-added (NVA) or waste, and necessary non value added (NNVA) [24]. Waste must be eliminated or reduced to a minimum to achieve the desired flow of health service processes in the future [8].

C. Data Processing

The findings from the VA, NVA and NNVA are described in VSM Current State and then various alternatives proposed based on VSM Current State analysis and simulation results. All alternatives obtained were then simulated to see the response of the system with the waiting time parameter [25]. The best waiting time would be the best alternative with various considerations [26].

Stages of optimization calculations to get the highest level of efficiency reducing the waiting time, namely:

- Collect patient waiting times for each alternative based on simulation results
- Calculate the difference between the real system waiting time and the model
- Calculate optimization of waiting time by:

$$\frac{\text{Selisih Waktu Tunggu}}{\text{Total Waktu Tunggu pada Sistem Nyata}} \times 100\% \quad (1)$$

III. RESULTS AND DISCUSSION

A. Queue System

Queuing system of Internal Medicine Polyclinic in Dr. RSUP Sardjito applies the First Come First Serve (FCFS) [20] system without considering the patient's condition. The system also does not apply the appointment scheduling. Registration of the polyclinic is opened from 07.00 a.m. to 14.00 p.m. The time of arrival and number of patients cannot be determined so that the system is likely to exceed the working hours that are opened starting at 8 am. Registration of the 4th floor IRC Hospital Dr. Sardjito is served from Monday to Friday.

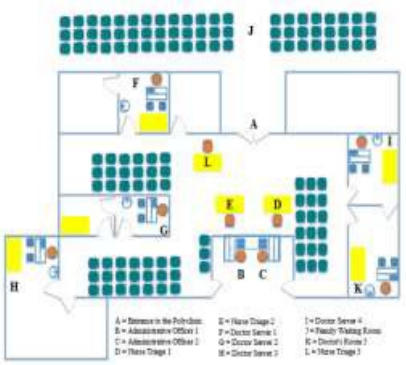

Figure 1: Layout of Internal Medicine Polyclinic

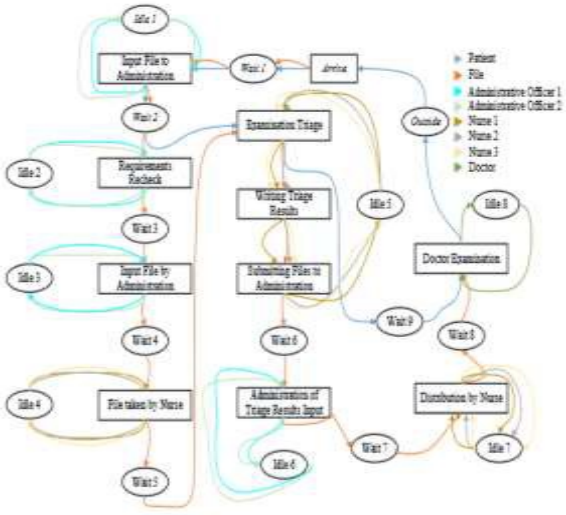

Figure 2: Activity Cycle Diagram

The system starts from the patient entering and submitting the medical file to the administration officer of the Internal Medicine Polyclinic. After the administrative process, the patient will wait in the waiting room to be called by triage service and continue to wait again to be called into the doctor's room. Patient waiting time will begin when the patient waits to be served until the patient out from the system. The system that has been identified is described in the system layout and Activity Cycle Diagrams shown in Figure 1 and Figure 2.

B. Development of the Real System Model

The model is eveloped to get an overview of the real system o the Internal Medicine Polyclinic of RSUP Dr. Sarjito so that real system performance can be measured and then the most optimal alternative can be made based on the results of analysis. The input data is as the following:

- Number of patient arrivals every day
- Probability of choosing a doctor
  Interarrival time of the patient
- Administrative service time
- Triage service time
- Doctor's service time
- Time of transportation of triage patients
- Time of transportation of doctor patients

- Time of file collection and distribution
- Time of writing the triage results

C. *Analysis of Simulation Models*

The main parameters used in this research for decision making are patient waiting time and length of queue

Table 1: Actual system report entity summary (Avg. Reps)

Replication	*Name*	*Total exits*	*Average Time in System* (Hr)	*Average Time in* Move Logic (Hr)	*Average Time Waiting* (Hr)	*Average Time in Operation* (Hr)	*Average Time Blocked* (Hr)
Avg	Patient exits	180,13	**5,17**	0,17	**4,82**	0,07	0,11

It can be seen from Table 5.29 that the total waiting time of patients is still very high, with an average replication of 4.82 hours. This can be concluded that about 93.23% of the total patient time in the system is allocated just for waiting.

D. *Value Stream mapping*

Once the system has been identified, then the VSM current state can be created, see Figure 3.

Based on the analysis of the VSM, current state problems that have been identified in the system are:

1) Value Added

- The process of opening files for new patients and old patients for patients' medical records as a treatment record for patients in polyclinics such as patient archive services.
- Triage services that involve examining the patient's initial diagnosis such as blood pressure, eyes, medical history, recording examination results, initial consultation and patient profile.
- Patient examination services by doctors starting from the initial examination, analysis of the disease and subsequent actions that must be taken by the doctor in medical treatment such as scanning

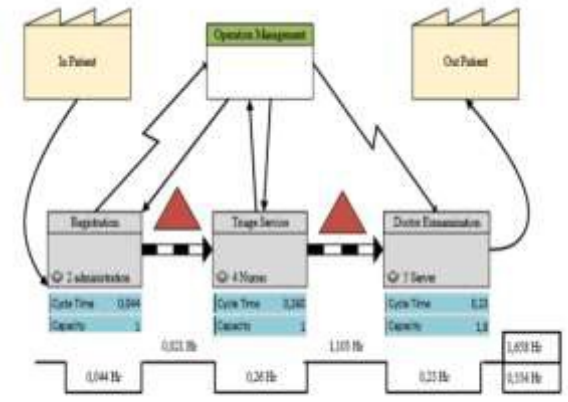

Figure 3: Current State Value Stream Mapping of Internal Medicine Polyclinic.

2) Non Value Added

- Redundant medical record writing as a result of triage examination (administration and triage services)
- Patients waiting to be called and examined (triage)
- Patients waiting to be called and examined (doctor)

3) Non Value Added but Needed

- The process of re-examining the conditions for submitting treatment at the Disease in Polyclinic.
- File taken by nurse in the administration section and distributed to each triage service
- Collection and distribution of files from the admin section to each doctor's room.

In addition, based on the simulation results of the actual model, other problems were identified, i. e:

- 93.23% For patient waiting time and 6.77% time allocation for others
- Current State does not meet Kepmenkes
- regulation No. 129[3]
- The considerable difference in total waiting time for triage and doctor's waiting time, see figure 4 and 5.

Based on these two analyses, various alternatives can be proposed which might reduce the system waiting time to comply with government regulation no. 129. Alternatives proposed are:Include patients by having them bring files Install pattern of calling patients in pairs

- Specific Jobs for nurses
- Add computer facilities for service
- Combination of alternative 1 and alternative 4
- The best combination of alternatives plus alternative 2

Figure 4. Actual system waiting time

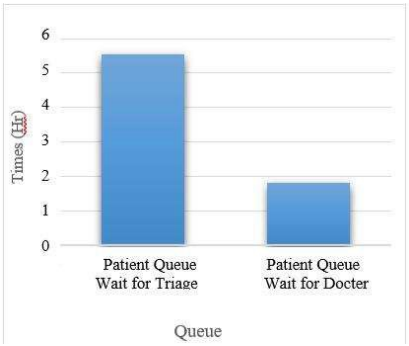

Figure 5. Average patient waiting time

E. Alternative Results Analysis

Alternative modeling plans are simulated and the results are based on the waiting time parameters. Each alternative can be applied in the triage section, the doctor's room and a combination of the two so that each alternative will have 3 sub-alternatives. The simulation results can be seen in Figure 6.

Based on the lowest waiting time histogram being in alternative 6B and the highest waiting time in alternative 3A, analysis of modeling results will only discuss the 5 lowest alternative waiting times and 1 alternative that provides the highest waiting time.

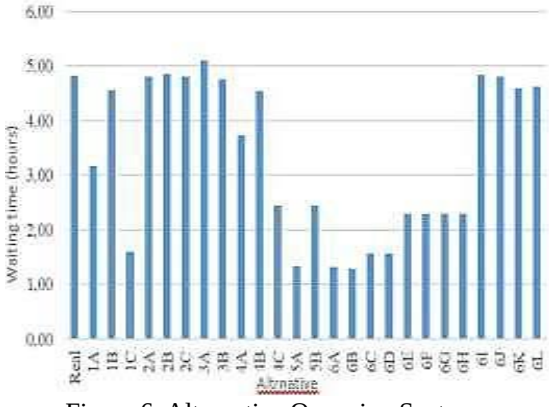

Figure 6. Alternative Queueing System

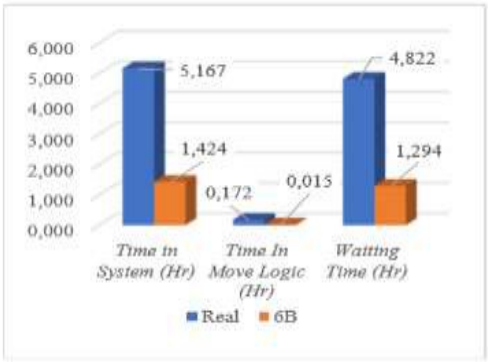

Figure 7: Comparison of Real System Simulation Results and Alternative Model 6B

Based on alternative 6B, the system can improve patient waiting time and total patient time as shown in Figure 7. Comparative histogram between real system and alternative simulation model. The percentage of changes was as much as 72,44% for the total time of the patient in the system and an 73,16% reduction of patient waiting time. The advantages of applying this alternative are:

1. Addition of human resources, namely one
2. nurse to increase service speed and reduce waiting time.
3. Eliminating the nurse's task in retrieving
4. and processing the file arrangement in the admin section, this is replaced by patients who will bring the file to the triage section
5. Eliminating the batch process that occurs
6. every time the nurse takes a file with the number of batch 10 processes, in real time the patient will automatically insert the file into the triage table section as specified by the admin.
7. Eliminating the transport time of triage
8. patients from the waiting room to the triage section by calling 2 patients for each triage.
9. Eliminating the transport time of patients
10. from the waiting room to the doctor's room with the pattern of calling 2 patients for each room.
11. Eliminating the time taken by the nurse in
12. returning the files to the admin section, being replaced by the patient, who delivers the file to the admin section. Patients who have returned files will then wait in the waiting room to be called by the doctor.
13. Eliminating nurse transport time in
14. distributing files from the admin section to each of the doctors' rooms because the task is replaced by computerized facilities that will be integrated through the admin section.
15. Balancing the triage process and checkingon real systems.

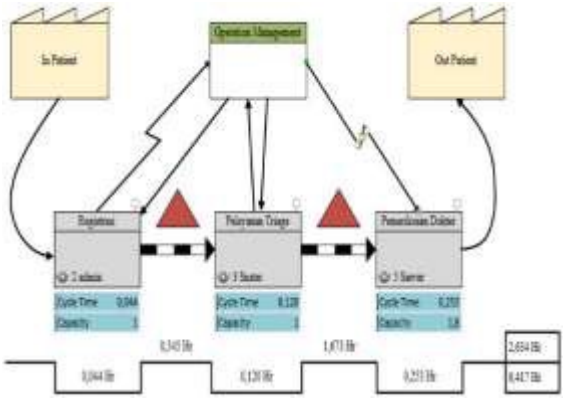

Figure 8: Future State Value Stream Mapping for alternative 6B

Alternative 6B still requires consideration of involving patients in terms of administration, this can still be resolved because every patient who enters the polyclinic will be accompanied by one or several people so that the administrative process can be carried out without the need for patients to participate in the

administrative process. The process of involving patients in the administrative order is a short-term solution that can be offered, while computerization will be a long-term solution to be applied in the polyclinic. The alternative by involving patients in the triage section is better than adding computerized facilities into the triage process, because there is a possibility that the patient's waiting time will be higher due to the triage process that is getting faster while the doctor's service is fairly constant.

Figure 8 shows that alternative changes can be seen with a higher throughput time with a percentage of 214% better than the current value stream mapping while the lead time decreases with a percentage reduction of 68.19%. The difference in alternative 6B of future state VSM and current state is located on a flat line and a broken pattern line that shows information has been distributed by computerized method, without having to be manually delivered by the nurse to the doctor's room, while the calling pattern cannot be seen in the picture and is only visible from the difference in lead time system changes

IV. CONCLUSIONS

From the results of identification of the system, there were 3 things about NVA and 3 things about NNVA, ie. redundancy of medical records written on the results of triage examinations, patients waiting to be called and examined in the triage section and in the doctor's section. NNVA on the system are: the process of re-examining the requirements for submitting treatment in the Internal Medicine Polyclinic, the nurse takes the file in the administration section and distributes the file to each triage service and the retrieval and distribution of files from the admin section to each doctor's room.

Value stream mapping is able to identify and eliminate or replace non value added steps as a Lean healthcare tool in the health industry world as stated by Wang and Huzzard [18] who say that Lean implementation tends to show better ability in the health industry than other models. Based on the results of the study, the system successfully identified various findings of existential problems in the system. The best alternative to be applied in the system to fulfill the regulation of The Minister of Health no. 129, was alternative 6B with a waiting time of less than 1 hour and a decrease of 73.16%.

This research still has not added risk analysis to alternative considerations so there are great opportunities for new alternatives to emerge which will provide more real alternatives in the system.

REFERENCES

[1] Poksinska, B 2010, 'The current state of Lean implementation in health care: literature review'. Quality Management in Health Care, (19), 4, 319-329

[2] Departemen Kesehatan, RI., 2009, Undang- Undang Nomor. 44 Tahun 2009 Tentang Rumah Sakit, Departemen Kesehatan Republik Indonesia, Jakarta.

[3] Parmenter, D., 2007, *Key Performance Indicators*, John Wiley & Sons, Inc., New Jersey.

[4] Kementerian Kesehatan, 2008, Kepmenkes Nomor:129/MENKES/SK/II/2008, Departemen Kesehatan, Jakarta.

[5] Media Komunikasi, Informasi dan Pendidikan RSUP Dr. Sardjito, 2016, Hasil Survei, *Buletin Sardjito Menyapa 2nd ed*.

[6] Ohno, T., 1998, *Toyota Production System: Beyond Large-Scale Production*, Productivity Press, Cambridge.

[7] Young, T., and Sally, M., 2009, Some Challenges Facing *Lean* Thinking in *Healthcare*, *International Journal for Quality in Health Care*, Vol. 21, No. 5: pp. 309-310

[8] Gill, P. S., 2012, Application *of Value Stream Mapping* to Eliminate *Waste* in an Emergency Room, *Global Journal Inc*, Vol. 12, Issue 6.

[9] Haron, S.H.A., 2015, Patient Process Flow *Improvement*: *Value Stream Mapping*, *Journal of Management Research*, Vol. 7, No. 2.

[10] Dinesh, T.A., Singh, S., Nair, P., and Remya T.R., 2013, Reducing *Waiting Time* in Outpatient Services *of* Large University Teaching Hospital – A Six Sigma Approach, *Amrita Institute of Medical Sciences and Research Centre*.

[11] Kagioglou, M., and Sapountzis, S., 2007, Applications *of Lean* Thinking A Briefing Document, *Healt and Care Infrastructure Research and Innovation Centre.*

[12] Silva, D., 2013, Improving Patient Flow Across Organisations and Pathways, *The Evidence Centre*, No. 19.

[13] Bronson, R., 1982, *Theory and Problems of Operation Research*, McGraw-Hill Higher Education, New York.

[14] Gross, D, and Harris, C. M., 1998, *Fundamental of Queuing Theory*, *3rd* ed., John Wiley and Sons, New York.

[15] Illin, V., 2015, Simulation Model *of* A Queuing *System*: The Case Study *of* A Fair Trade Manifestation in Novi Sad, *2nd Logistics International Conference.*

[16] Heizer, J.H., and Render, B., 2005, *OperationManagement*, 7th ed., Prentice Hall, New Jersey.

[17] Hillier, F.S., and Lieberman, 2001, *Introduction to Operations Research*, 7th ed., McGraw-Hill Higher Education, New York.

[18] Wang, Y., and Huzzard, T., 2011, The Impact *of Lean* Thinking on Organizational Leaming, *Knowledge and Capabilities Conference Proceedings*.

[19] Nelson, J. L., and Buggy, J. M., 2005, Applying *Lean* Production In *Healthcare* Facilities, *InformeDesign Research*, Vol. 06, No. 05.

[20] Khoshnevis, B., 1994, *Discreet Systems Simulation*, McGraw-Hill, Inc., New York.

[21] Jin, X., and Lim, S.Y., 2013, A Simulation Based *Analysis* on Reducing Patient *Waiting Time* for Consultation in an Outpatient Eye Clinic,*Winter Conference.*

[22] Jing, W., and Lilei, 2016, Simulation Research on Jingdong Orders *System* Based on Flexsim, *International Journal of Multmedia and Ubiquitous Engineering*, Vol. 11, No. 6, pp. 369-395.

[23] Boos, H., and Frank, Z., 2013, *Lean* Principles In Healthcare Rehabilitation Suggestions For Implementation, *The Seventh International Conference On Healthcare Systems & Global Business Issues.*

[24] Hines, P., and Rich, N., 1997, The Seven *Value Stream Mapping* Tools, *International Journal of Operation & Production Management*, Vol. 17, Isn: 1, pp. 46 – 64.

[25] Vijay, S. A., 2014, Reducing and Optimizing The *Cycle Time of* Patients Discharge Process in A Hospital Using Six Sigma DMAIC Approach, *International Journal for Quality Research.*

[26] Koelling, C.P., Eitel, D., Mahapatra, J. S., Messner, K., and Grove, J. L., 2001, *Value Stream Mapping* the Emergency Department,*Grado Department of Industrial and Systems Engineering.*

[27] Moore, R., Lopes, J., 1999. Paper templates. In *TEMPLATE'06, 1st International Conference on Template Production*. SCITEPRESS.