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Reduction of Emergency Room Service Time at St. Carolus Summarecon Serpong Hospital, Indonesia with DMAIC Approach in 2023

Christina Saputera[1*], Masyitoh Basabih[2]
**Correspondence Author: chres1985@gmail.com*
[1] Master of Hospital Administration Program, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia
[2] Department of Health Policy and Administration, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia

INDEXING

Keywords:
Service time;
Emergency room;
Non-value-added;
Waste;
Lean Six Sigma

ABSTRACT

Service time is one of the quality ER's indicators that is still a problem in various hospitals. This study was conducted based on the ER's quality indicator achievement, service time ≤ 3 hours at St. Carolus Summarecon Serpong Hospital which always does not reach the target (74,3% of the target > 90% of total ER inpatients) and is reinforced by the researcher's search in SINTA indexed journals, there has been no research discussing the ER's service time improvement using DMAIC interventions up to the control stage. The result using operational research design, blended method and probability sampling techniques (a sample of 32 ER patients) successfully identified unplanned discharges of inpatients to cleaning service staff, room entrustment policies, waiting lists for VIP rooms, and the lack of human resources for inpatient nurses, as the root cause of the problem, reducing lead time from 4:14 to 2:39:2 (↓ 37,4%) at the post-intervention stage and to 2:19:46 (↓ 12,1%) at the control stage; reduce non value-added activities from 1:38:19 to 32:22 (↓ 67,1%) at the post-intervention stage and to 25:23 (↓ 21,6%) at the control stage and successfully eliminate waste transport, reduce waste waiting time and lead time by 55%.

Kata kunci:
Waktu layanan;
Unit Gawat Darurat (UGD);
Tidak bernilat tambah;
Pemborosan;
Lean Six Sigma

Service time merupakan salah satu indikator mutu pelayanan IGD yang masih menjadi masalah di berbagai RS. Penelitian ini dilakukan atas dasar pencapaian service time ≤ 3 jam di IGD RS St. Carolus Summarecon Serpong yang selalu tidak mencapai target(74,3% dari target > 90% total pasien rawat inap IGD)dan diperkuat dengan hasil penelusuran Peneliti pada jurnal terindeks SINTA, ditemukan bahwa belum ada penelitian yang membahas tentang perbaikan service time IGD dengan intervensi DMAIC sampai pada tahap kontrol. Hasil penelitian menggunakan desain operational research, blended method dan teknik probability sampling (sampel sejumlah 32 pasien IGD), berhasil mengidentifikasi waste waiting pada tahap transfer pasien IGD ke ruang rawat inap sebagai penyebab akar masalah, menurunkan lead time dari 4:14 menjadi 2:39:2 (↓ 37,4%) pada tahap post intervensi dan menjadi 2:19:46 (↓ 12,1%) pada tahap control; menurunkan aktivitas non value-added dari 1:38:19 menjadi 32:22 (↓ 67,1%) pada tahap post intervensi dan menjadi 25:23 (↓ 21,6%) pada tahap control dan berhasil mengeliminasi waste transport dan menurunkan waktu waste waiting dan lead time sebesar 55%.

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INTRODUCTION

The characteristics of emergency room (ER) services, which are fast, efficient, and effective across units, with a high stress level, create opportunities for problems in the service (Nhdi et al., 2021). One of the output problems that often occurs in the ER is the long length of stay of ER patients to the inpatient room (service time), which means patient service from entering the ER (arrival at the ER door) until being transferred to the inpatient room. Time is a highly prioritized component in emergency department services (apart from effectiveness and efficiency), and its achievement can be measured monthly and provide a general picture of the ER's quality (Wati et al., 2022). Several previous studies on the average ER's service time were < 4 hours, which includes at least 85% of total ER patients (Sullivan et al., 2015), and < 8

hours for all triage categories for inpatients from ER (McLeod et al., 2020). ER service time is often a problem in many hospitals globally, including Indonesia. Mentzoni, Ida *et al*, through their research from January 1st, 2010-31st December 2015found that the average ER service time was between 3 hours 45 minutes to 4 hours 17 minutes, with 37,9% experience overcrowding in 2010 and 52,9%-77,6% in 2011-2015(Mentzoni et al., 2019). Nationally, Wahab, Abdul Encep *et al*, through quantitative research with a retrospective method and a cross-sectional analytical approach during March until May 2021, found that the ER's waiting time ≥ 6 hours at Cibinong Regional Hospital was 45,6% (Wahab et al., 2021).

Understanding the importance of time in health services, gives rise to various frameworks to increase effectiveness and efficiency in the process; one of which is DMAIC (Define, Measure, Analyze, Improve and Control); methods used in Lean Six Sigma, which was first developed by Bill Smith at Motorolla in the late 1980s. This framework begins with the concept that problems with quality are mostly due to inadequate design, which results in waste, delays, rework and variations in process; impact on increasing production time and cost. Miguel Ortiz Barrios et al, using Lean Six Sigma, a combination of DMAIC and Supplier, Input, Process, Output, Control (SIPOC) tools, succesfully identified the long waiting time for supporting examinations as the main cause and reduced the ER's service time by a total of 87 minutes from the previous 190,2 minutes to 130,1 minutes (Angel Ortíz-Barrios & Alfaro-Saíz, 2020).

The challenge faced by the ER's St. Carolus Summarecon Serpong Hospital is the failure to achieve the target service time of ≤ 3 hours, which covers only 74,3% of the total 90% inpatients in the ER due to multifactorial, cross-unit causes, and variations in the implementation process. This study aims to answer the flow of the ER's service time; value-added, non-value-added activities and waste that affect the ER's service time; the root of the problem that caused the ER's service time not to reach the target and how the DMAIC approach improves the ER's service time.

Based on the background above and the absence of research on DMAIC interventions up to the control stage, including research conducted by Theryoto at Koja Regional Hospital in 2017 (Theryoto & Nadjib, 2017) and Husna Yulianingsih *et al* at University Gajah Mada Academic Hospital in 2021 (Yulianingsih & Meliala, 2021), reinforced by the researcher's research in SINTA-indexed journals, there has been no research discussing ER's service time improvement using DMAIC intervention up to the control stage. In response to the above, the researchers are encouraged to conduct research by identifying, analyzing, planning strategies and implementing up to the control stage using the DMAIC approach.

RESEARCH METHOD

This study used an operational research design by combining quantitative and qualitative research methods (blended method), carried out in the ER St. Carolus Summarecon Serpong hospital for 2 (two) periods starting from October to November 2023 (having received ethical approval from the Public Health Research and Service Ethics Commision, Faculty of Public Health, University of indonesia with number: Ket-722/UN2.F10.D.11/PPM.00.02./2023). The sampling technique used in this study was probability sampling, with a simple method using simple random sampling.

The number of samples in this study was determined to be 32 (thirty two) respondents per month, distributed according to the number of days from Monday to Sunday, 2 (two) shifts

(morning and night), for 7 (seven) working days and covering all emergency triage criteria (emergency, urgent, and non-urgent) during October 2023 with a sample size ratio for morning and night shifts of 1:2. This study also carried out data collection which was used to explore findings from quantitative data collection. Qualitative data were collected by conducting focus group discussions (FGD). FGDs were conducted with the hospital director, hospital medical services director, ER doctor on duty, ER nurse, ER administration officer, and head of the inpatient room to discover obstacles and problems in the ER service time process.

This study's data collection technique collected primary data through direct observation and FGD, and secondary data by looking at patient medical records, standard operating procedures (SOP), guidelines, manuals, and supporting legislation. The univariate analysis technique in this study was used to calculate lead time, cycle time, value-added, and non-value-added activities to produce the value-added ratio (VAR), which could then determine the root of the service time problem in the ER at St. Carolus Summarecon Serpong. The qualitative data analysis technique in this study uses content analysis, an in-depth understanding of the phenomenon being studied. Quantitative data from this study will be processed and analyzed using the Lean Six Sigma (DMAIC) approach. In this study, the validity of qualitative data was tested using the triangulation method, namely by combining direct observation and FGD methods.

RESULTS AND DISCUSSION

Define Stage

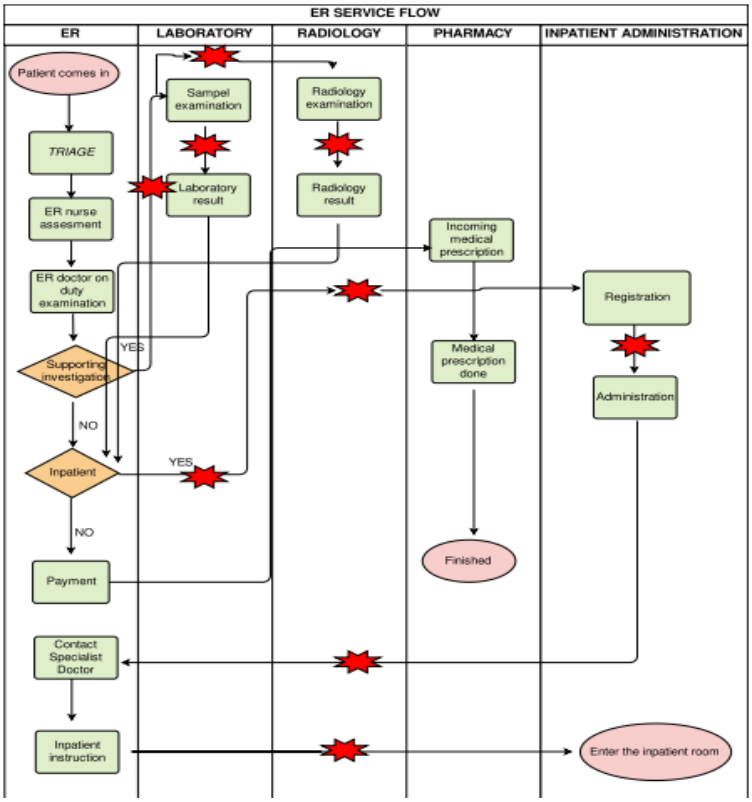

Figure 1. Flowchart of ER Service Time at St. Carolus Summarecon Serpong Hospital

Source: *Primary Data, 2023*

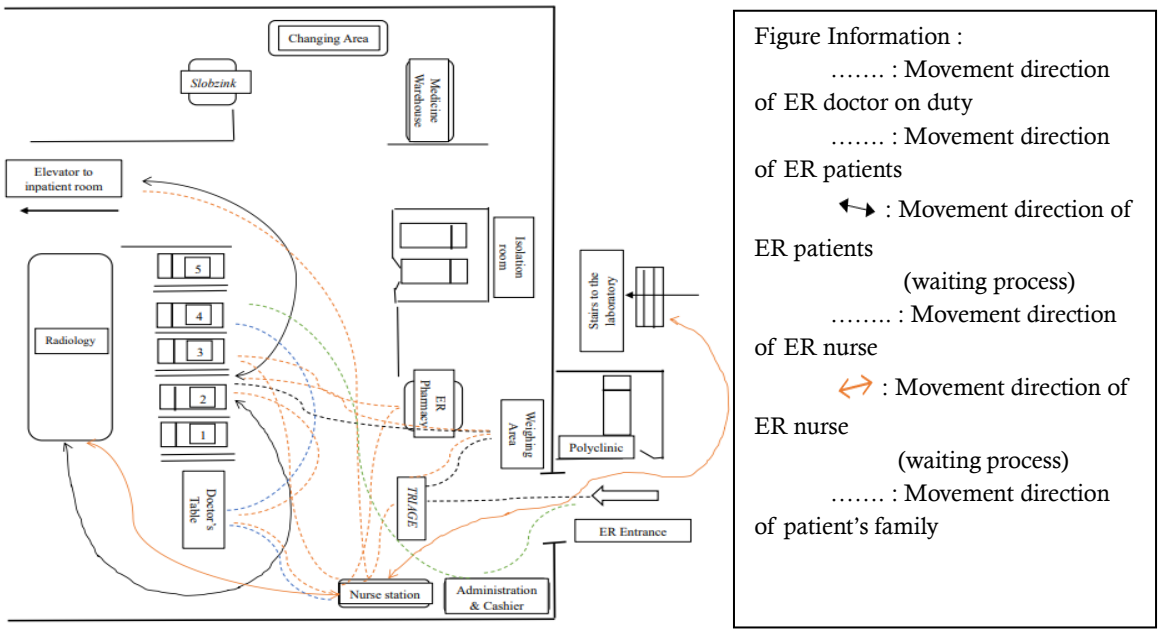

Figure 2. Spaghetti Diagram of ER Service Time at RS St. Carolus Summarecon Serpong Hospital

Source: *Primary Data, 2023*

Measure Stage

Table 1. Value-Added and Non-Value-Added in The ER Service Time Process

No	Activity	Cycle Time	VA		NVA		Waste	
			Time	%	Time	%	Type	Time
1	*Triage*	00:02:34	00:02:34	100	-	-	-	-
2	ER Doctor examination	00:02:47	00:02:47	100	-	-	-	-
3	Supporting examination	02:01:36	01:32:34	76.1	00:29:02	23.9	-Waiting -Transport	00:21:50 00:07:12
4	Inptaient decision	00:44:13	00:31:39	71.6	00:12:34	28.4	-Waiting	00:12:34
5	Inpatient registration	00:36:43	00:22:21	60.9	00:14:22	39.1	-Waiting	00:14:22
6	Patient transfer to the inpatient room	00:46:56	00:04:36	9.8	00:42:21	90.2	-Waiting	00:42:21
	Mean Lead Time 04:14:00		02:36:30	61.4	01:38:19	38.6		01:38:19

Source: *Primary Data, 2023*

Table 2. Percentage of Non-Value-Added in The ER Service Time Process

No	Activity Stage	Non-Value-Added	
		Time	% NVA
1	*Triage*	-	-
2	ER Doctor examination	-	-
3	Supporting examination	00:29:02	29.5 %
4	Inpatient decision	00:12:34	12.8 %
5	Inpatient registration	00:14:22	14.6 %
6	Transfer the patient to the inpatient room	00:42:21	43.1 %
	Total	01:38:19	100

Source: *Primary Data, 2023*

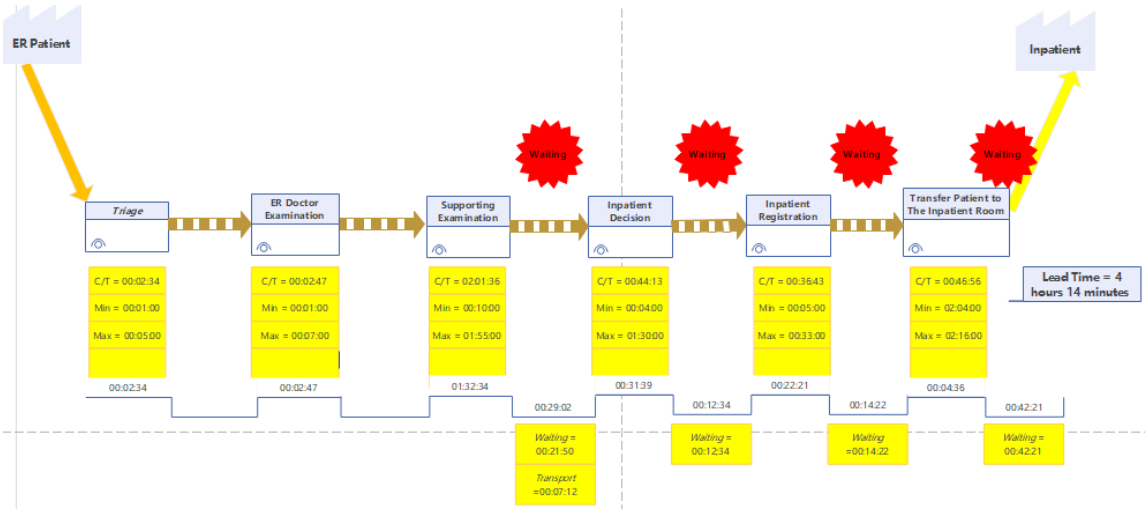

Figure 3. Current State Value Stream Map ER Service Time at St. Carolus Summarecon Serpong Hospital

Source: *Primary Data, 2023*

Analyze Stage

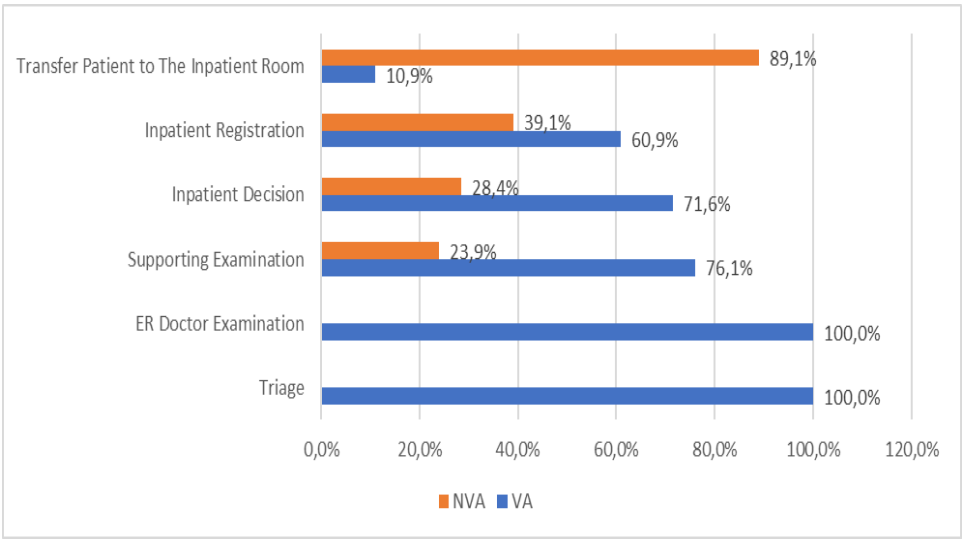

Figure 4. Percentage of Value-Added and Non-Value-Added Activities in The ER Service Time at St. Carolus Summarecon Serpong Hospital

Source: *Primary Data, 2023*

Table 3. Waste Identification During ER Service Time at St. Carolus Summarecon Serpong Hospital

No.	Activity Stage	Description of Activities	Waiting	Transport	Total
1	Supporting examination	Waiting ER nurse to take the patient's blood sample	00:03:10		00:03:10
		Laboratory staff delivered the laboratory result to the ER.		00:07:03	00:07:03
		Waiting for radiology examination because another patient is still using the radiology equipment	00:08:00		00:08:00
		The radiographer delivered the radiology result to the ER.		00:10:49	00:10:49
	Total Time Supporting Examination		00:11:10	00:17:52	00:29:02
2	Inpatient Decision	Waiting supporting the examination result from the ER doctor	00:04:00		00:04:00
		Waiting patient's/family's decision	00:08:34		00:08:34
	Total Time Inpatient Decision		00:12:34		00:12:34
3	Inpatient Registration	Waiting for room assignment	00:14:22		00:14:22
	Total Time Inpatient Registration		00:14:22		00:14:22
4	Transfer Patient to Inpatient Room	Waiting for the inpatient room to be empty of the previous patient	00:11:12		00:11:12
		Waiting inpatient room to be cleaned	00:19:10		00:19:10
		Waiting for the inpatient nurse who will hand over the ER's patient	00:11:59		00:11:59
	Total Time Transfer Patient to Inpatient Room		00:42:21		00:42:21
		Total	01:20:27	00:17:52	01:38:19

Source: *Primary Data, 2023*

Based on pareto analysis, the researchers concluded cause of the lengthening ER service time at St. Carolus Summarecon Serpong includes activities waiting for the inpatient room to be cleaned (27,7%), waiting for the inpatient room to be assigned (20,7%), waiting for the inpatient nurse to hand over the ER patient (17,3%), and waiting for the inpatient room to be empty from previous patient (16,2%); with a total of 81,9%. Analysis using the five whys technique, with conducting FGD (together with the specified parties) to identify the root causes of the waste waiting problem in the 4 activities mentioned above.

Table 4. Five Whys Analysis Root Causes of ER Service Time Problem at St. Carolus Summarecon Serpong Hospital

Activity	Root Causes
Waiting for the inpatient room to be cleaned	1. The inpatient room has not been cleaned 2. Waiting for the cleaning service and nursing assistant to clean the room and change the linen 3. Cleaning service staff do not stand by in the inpatient unit 4. There is only one nursing assistant on each floor, and they are still helping another patient's needs 5. Information on unplanned cleaning of the inpatient room
Waiting for room assignment	1. Information about placement rooms is still not optimal 2. Room assignment still uses the manual method by telephone to the inpatient room 3. The use of the existing bed information system is not optimal 4. The existing bed information system interface currently needs an addition 5. There needs to be a review and discussion between the inpatient administration, users and inpatient nurses in the process of improving the bed information system interface
Waiting for the inpatient nurse who will hand over the ER's patient	1. The inpatient nurse has been unable to do a handover with an ER nurse. 2. The nurse station is often empty. 3. The inpatient nurse still carries out procedures or goes around the patient's room. 4. The distribution of inpatient nurses in each room per shift is not optimal. 5. ICU's unit still assists the inpatient nurse in their staffing, meaning that when there are ICU patients, there will be a temporary imbalance in terms of the number of inpatient nurses compared to the number of patients
Waiting for the inpatient room to be empty by the previous patient	1. Room availability 2. Waiting list system 3. Waiting for patients who have not left the inpatient room because their families have not yet picked them up, they are still taking care of administration, especially insurance patients. 4. Waiting for the patient to move to a room with a VIP waiting list 5. Inpatient room rental policy

Source: *Primary Data, 2023*

Improve Stage

Table 5. Types of Interventions Carried Out Based on Root Cause Problem Analysis

No.	Activity Stage	Type of Intervention	ER	Inpatient Unit
1	Inpatient Registration	Short-term	Revising the standard operational procedure of transferring ER's patient to the inpatient room to shorten the ER service flow by using single-minute exchanges of die	- Resocializing of patient admission standards in care units - Reviewing and optimizing the bed information system
		Long-term	-	Reviewing and optimizing the bed information system
2	Transfer ER Patient to Inpatient Room	Short-term	-	Calculating the need for inpatient nurses based on the number of inpatients by using Heijunka tools
		Long-term	-	Reviewing and optimizing the bed information system

Source: *Primary Data, 2023*

1. Inpatient Registration Stage

1.1.ER

Researchers used the Single Exchanges of Die Tool by revising the Standard Operational Procedure for transferring patients from the ER to shorten the ER's service flow who will be admitted to the inpatient room. The analysis results support the selection of this intervention, where the inpatient registration stage can only be carried out after there are supporting examination results.

1.2.Inpatient Room

Researchers use visual management tools to provide recommendations in the form of:

1.2.1 Conduct a review of the bed information system's effectiveness, currently used to make it real-time following dynamic conditions in the inpatient room. This recommendation is expected to improve and maintain the ER's service time achievement in the long term.

1.2.2 Determine specific hours for moving rooms on the waiting list for inpatients.

2. Transfer ER Patient to The Inpatient Room Stage

2.1.Implementing the Heijunka tool to provide recommendations for calculating the need for room nurses based on the number of inpatients and Just In Time for distributing nurses based on patient care room groups. It aims to provide recommendations for the inpatient room's head nurse to optimize existing human resources without adding personnel.

2.2.Implementing the Heijunka tool by recommending to the inpatient room's head nurse to make a list of patients going home during the morning shift and submit it to the cleaning service staff and nurse assistant to make the cleaning of used treatment rooms more planned.

2.3.Implementing Standardized Work by re-socializing the standard time for receiving new patients in the care unit to all room nurses, 15-30 minutes after the booking room is requested.

Table 6. Percentage Comparison of Non-Value-Added Pre-Intervention and Post Intervention ER Service Time at St. Carolus Summarecon Serpong Hospital

No.	Activity Stage	Pre-Intervention		Post-Intervention		Comparison %
		Time	% NVA	Waktu	% NVA	Pre-Post
1	*Triage*	-	-	-	-	-
2	ER doctor examination	-	-	-	-	-
3	Supporting examination	00:29:02	29.5%	00:11:20	35%	↓ 61%
4	Inpatient decision	00:12:34	12.8%	00:08:33	26.4%	↓ 32%
5	Inpatient registration	00:14:22	14.6%	00:05:19	16.4%	↓ 63%
6	Transfer the patient to the inpatient room	00:42:21	43.1%	00:07:10	22.1%	↓ 83.1%
	Total	01:38:19	100%	00:32:22	100%	↓ 67.1%

Source: *Primary Data, 2023*

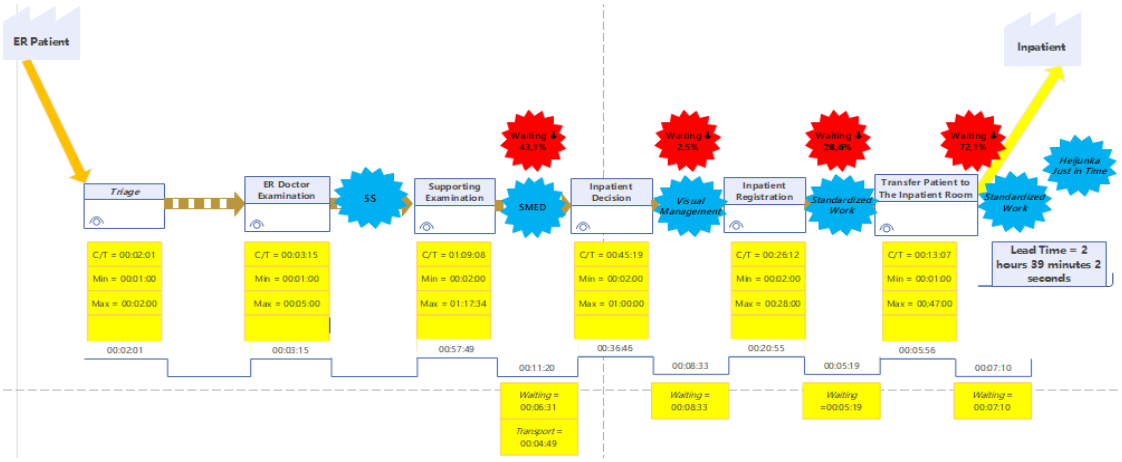

Figure 5. Future Value Stream Map Post-Intervention (Future State Map Control) ER Service Time at St. Carolus Summarecon Serpong Hospital

Control Stage

Based on the future state map in the control stage, the researchers attempted to carry out several intervention trials to reduce the cycle time of ER service time activity stages in addition to maintain the results of post-intervention data, by re-socializing radiographers that all radiological examinations from ER are a priority (cito), applying 5S tools to make the ER work area more concise and clean, implementing visual cycle time management stages of ER service time activities to maintain previous achievements by displaying run charts every month on the ER board information so that every ER member team can see service time achievements every month.

Table 7. Comparison of ER Service Time at St. Carolus Summarecon Serpong Hospital Pre-, Post-Intervention, and Control

No	Activity Stage	Pre-Intervention			Post-Intervention			Control			CT Pre–Post (%)	CT Post Control (%)
		VA	NVA	CT	VA	NVA	CT	VA	NVA	CT		
1	Triage	00:02:34	-	00:02:34	00:02:01	-	00:02:01	00:02:43	-	00:02:43	↓ 21.4%	↑ 34.7%
2	ER doctor examination	00:02:47	-	00:02:47	00:03:15	-	00:03:15	00:02:34	-	00:02:34	↑ 16.8%	↓ 21.0%
3	Supporting examination	01:32:34	00:29:02	02:01:36	00:57:49	00:11:20	01:09:08	0:50:41	00:05:44	00:56:25	↓ 43.1%	↓ 18.4%
4	Inpatient decision	00:31:39	00:12:34	00:44:13	00:36:46	00:08:33	00:45:19	00:32:00	00:08:21	00:40:21	↓ 2.5%	↓ 11.0%
5	Inpatient registration	00:22:21	00:14:22	00:36:43	00:20:53	00:05:19	00:26:12	00:20:55	00:04:45	00:25:40	↓ 28.6%	↓ 2.0%
6	Transfer the ER patient to the inpatient room	00:04:36	00:42:21	00:46:56	00:05:56	00:07:10	00:13:07	00:05:30	00:06:34	00:12:04	↓ 72.1%	↓ 8.0%
	Total	02:36:30	01:38:19	04:14:00	02:06:40	00:32:22	02:39:02	01:54:23	00:25:23	02:19:46	↓ 37.4%	↓ 12.1%

Source: *Primary Data, 2023*

Table 8. Percentage Comparison of Non-Value-Added Pre-, Post-Intervention, and Control in ER Service Time at St. Carolus Summarecon Serpong Hospital

No	Activity Stage	Pre-Intervensi		Post-Intervensi		Control	
		Time	% NVA	Time	% NVA	Time	% NVA
1	Triage	-	-	-	-	-	-
2	ER doctor examination	-	-	-	-	-	-
3	Supporting examination	00:29:02	29.5%	00:11:20	35%	00:05:44	22.6%
4	Inpatient decision	00:12:34	12.8%	00:08:33	26.4%	00:08:21	32.9%
5	Inpatient registration	00:14:22	14.6%	00:05:19	16.4%	00:04:45	18.7%
6	Transfer the ER patient to the inpatient room	00:42:21	43.1%	00:07:10	22.1%	00:06:34	25.9%
	Total	01:38:19	100%	00:32:22	↓ 67.1%	00:25:23	↓ 21.6%

Source: *Primary Data, 2023*

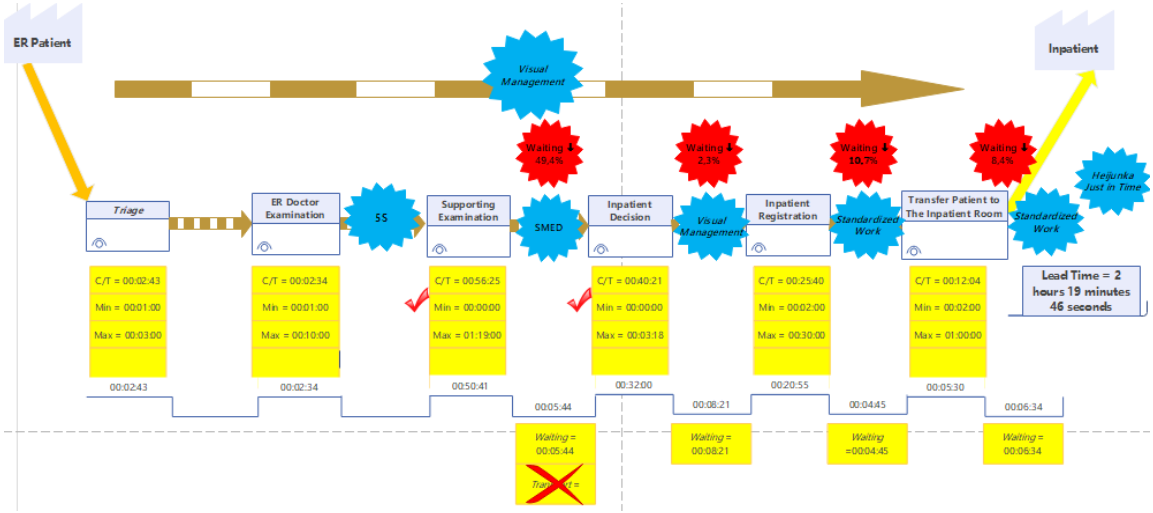

Figure 6. Current Value Stream Map Control Stage of ER Service Time at St. Carolus Summarecon Serpong

Source: *Primary Data, 2023*

Discussion

Overview: Flow of ER Service Process with Service Time

ER is the front guard of hospital health services and works continuously with high density (Saputera et al., 2020). The flow of the ER service process in general consists of 4 (four) stages: door to doctor, door to decision, door to transfer, and door to discharge (Andersson et al., 2020). This service flow is also implemented at St. Carolus Summarecon Serpong hospital by breaking down door to doctor and door to decision into 2 (two) stages; produce the entire flow consists of 6 (six) stages: triage, ER doctor examination, supporting examination, inpatient decision, inpatient registration, and transfer ER patient to the inpatient room. Based on policy perspectives in Indonesia, the flow of ER services at St. Carolus Summarecon Serpong follows Minister of Health Regulation Number 47 of 2018, point III.B regarding ER Intrafacility Health Services in Hospitals. Currently, there is no standard ER service time set by the government; thus, each hospital's policy standard for ER service time can vary according to existing facilities and infrastructure. Andersson et al in their research in 2020, stated that the

ER patient's stay time was 6 (six) hours; 4 (four) hours according to the National Health System of the UK (Andersson et al., 2020).

The complexity of the ER results in various variations in the patient service process, thus affecting the resulting quality and performance (Otto et al., 2022). It is the basis for determining service time as an indicator of hospital ER service quality. Service time also indicates ER service quality at St. Carolus Summarecon Serpong, with a standard time of ≤ 3 hours for >90% of hospitalized ER patients. Based on observations and calculations carried out by researchers in October 2023, it was found that the ER service time at St. Carolus Summarecon Serpong is 4 hours 14 minutes. This achievement still exceeds the time standard set by hospital management, which is ≤ 3 hours. The results align with several other studies where the ER service time still exceeds the time standards that have been set, including research by Nurhidayat et al in 2020 at Meuraxa District Hospital of 6 (six) hours (Nurhidayat et al., 2020). Abdul Wahab in 2021 at Cibinong Regional Hospital, the ER service time was still > 6 (six) hours in 2020 data (Wahab et al., 2021), Yuyun Suciati in 2021 at RSUP Dr. Sardjito Yogyakarta was 473 minutes (Suciati, 2021). Achievement of ER service time at St. Carolus Summarecon Serpong has not been proven to be lean, where the results of this research still exceed the time standards set by hospital management. The research results, which have not reached the target time, are also due to the large variations in ER services; thus, an appropriate Lean Six Sigma method is needed to minimize existing variations (Bonamigo et al., 2022). while the ER service time at St. Carolus Summarecon Serpong is still included in the un-lean category, where the non-value-added percentage reaches 38,6%.

Analysis of Value-Added (VA), Non-Value-Added (NVA), and Waste Activities

VA, NVA, and waste activities above align with the lean concept, which aims to identify the activities and timing of each stage to identify points in the process that do not provide added value for customers (Ristyowati et al., 2017). The research found 18 (eighteen) value-added activities in the ER service time at St. Carolus Summarecon Serpong hospital, where the triage activity stage and ER doctor examination were 100% value-added activities. The process in the 2 activity stages is efficient and effective, thus it does not cause waste, which can extend service time. The research found 10 non-value-added activities in the ER service time at St. Carolus Summarecon Serpong hospital, where waiting is the highest type of waste, followed by transport waste. The longest waste is waste waiting, which is found in ER patient transfer activities to inpatient rooms at 52,6% (00:42:21) and inpatient registration at 17,9% (00:14:22).

High waste waiting is the cause of prolonged ER service time at St. Carolus Summarecon Serpong, in line with research conducted by Nurhidayat et al (2020) at RSI PKU Muhammadiyah Tegal, where waste waiting is included in the 3 main wastes that cause the waiting time for transferring ER patients to inpatient rooms to be prolonged (Nurhidayat et al., 2020). Waste transport is another cause of lengthening the ER service time at St. Carolus Summarecon Serpong, in line with research conducted by Theryoto and Mardiati Nadjib (2017), where waste transport plays a role in non-value-added boarding time activities in the ER at Koja Regional Hospital (Theryoto & Nadjib, 2017).

Analysis Root Cause Problem

The cause of problems in this research was identified using Pareto analysis and the five whys. Pareto analysis ranks potential causes that must be worked on first (Wiranto, 2023). The

Pareto principle concludes that 80% of problems can result from 20% of the causes (Abyad, 2021); thus, this principle is often known as the 80-20 method. The prioritized potential causes are the occurrences of the most frequent causes in a particular category. The results of this study found 3 root causes of the problem: waste waiting during the transfer of the ER patient to the inpatient room (52,6%), inpatient registration (17,9%), and the inpatient decision (15,6%), with an overall total of 86,1%. The causes of waste from the 3 (three) activity stages based on the description of the activities consist of waiting for the inpatient room to be cleaned (27,7%), waiting for room assignment (20,7%), waiting for the inpatient nurse who will hand over the ER patient (17,3%), and waiting for the inpatient room to be empty from the previous patient (16,2%); with a total of 81,9%.

The five whys analysis was then used to find the root cause. The results were information on unplanned discharges of inpatients to cleaning service staff, room entrustment policies and waiting lists for VIP rooms, and the lack of human resources for inpatient nurses. The choice of the five whys method aims to understand and find the problem root cause by asking questions repeatedly in and structured manner (Serrat, 2017). The Pareto analysis and five whys used in this research can identify non-value-added activities more sharply by calculating the highest percentage that impacts the hospital, and a qualitative analysis of the causes of activity variations. This combination is expected to eliminate non-value-added activities, which in percentage terms appear high, but in qualitative analysis are value-added.

Analysis of DMAIC Implementation

The researcher designed several intervention strategies based on the problem root cause description. Intervention activities include waiting for the inpatient room to be cleaned using standardized work tools through re-socialization and a periodic standard time of 15 to 30 minutes for accepting new patients in the inpatient unit. Istvan Vajna and Anita Tangl (2017) stated that standardized work is a tool used to create processes that do not produce waste and create the best management in a sustainable manner (Vajna & Tangl, 2017). Standardized work intervention is also carried out in waiting activities for room nurses who will carry out hand-overs of the ER patient through repeated and ongoing socialization regarding the standard time for admitting patients to the inpatient room, which is 15-30 minutes. Standardized work is also used as an intervention in supporting examination activities on the control stage through re-socialization to radiographers that all radiological examinations from ER are a priority (cito).

Another intervention using a Heijunka tool involves providing recommendations to the head room nurse to make a list of patients returning home every morning to be given to the cleaning service staff and nursing assistants, thus the cleaning process is more planned. Heijunka was the first tool to equalize processes and production through leveling and sequencing mechanisms (Pandya et al., 2017). A process that is kept balanced and even will make the overall process flow smoothly, and the time required will be shorter. Equal production distribution aims to avoid buildup and produce products with minimal capital according to funds, resources, and lead time. This concept is also applied to intervention activities, waiting for the inpatient nurse who will hand over the ER patient through recommendations submitted to the head room nurse regarding calculating resources based on the number of inpatients and a clear, specific division of tasks for all nurses on duty, which is socialized every shift.

Heijunka can make the workload distributed evenly, thus there is a balance in each unit. The process can run smoothly with intervention using the single minute exchange of die (SMED) tool is used in the activity of waiting for room assignment through the patient's family directly arranging an inpatient room without waiting for supporting examinations results if, according to the ER doctor assessment, the patient needs to be hospitalized. The intervention carried out by researchers aligns with Bonamigo et al (2022) where SMED aims to make health services learners with less waiting time and stress levels for patients and maximizing production quality (Bonamigo et al., 2022).

Intervention using visual management tools is carried out at the activity stage of waiting for the inpatient room to be empty from the previous patient and waiting for the room assignment through reviewing and optimizing the bed information system. In his research, Algan Tezel (2016) stated that the focus of these tools is to help solve certain information needs problems by developing tools (Tezel et al., 2016). Another intervention researchers in the ER area implemented was 5S (Sort, Straighten, Shine, Standardize, and Sustain). The 5S method implemented in the ER pharmacy area reduced waste waiting: waiting for the ER nurse to take a patient's blood sample by 17,5%, from 3 minutes 10 seconds to 2 minutes 37 seconds. These results are in line with research conducted by Amanda (2022) where the 5S method can increase value-added activities by 61,38% and reduce non value-added activities by 38,62%; which then had an impact on increasing customer satisfaction for ER patients from 60,28% to 77,78% (Pinta et al., 2022).

Analysis of ER Service Time Results After Implementing DMAIC

Based on the result of post-intervention research, there was a decrease in lead time of 37,1% with the largest non-value-added reduction percentage at the transfer activity stage of ER patients to the inpatient room at 83,1% and inpatient registration activities at 63%. Based on the activity description, there was a decrease in non-value-added activities by 80% in activities waiting for the inpatient room to be cleaned and in activities waiting for the room assignment by 62,8%. The lean method can be proven to eliminate waste and increase the value-added of a product/ service, thus having an impact on improving quality (Kaneku-Orbegozo et al., 2019). These results are in line with the research conducted by Nurhidayat et al (2020) at RSI PKU Muhammadiyah Tegal, where lean can reduce the waiting time for transferring ER patients to the inpatient room from 39,9 minutes to 28,5 minutes (Nurhidayat et al., 2020).

Based on the research result at the control stage, when compared with the post-intervention results, there was a decrease in lead time of 12,1% with the largest decrease in the supporting examination activity stage of 49,4% and, resulting in an overall decrease in the percentage of non-value-added activities of 21,6%. These results are in line with research conducted by Eveline et al (2017) at the American University of Beirut Medical Center, where lean intervention can reduce the cycle time for supporting examinations from 22,2 minutes to 9,9 minutes with an increase in patient coverage from 32,3% to 71,6% post-intervention (Hitti et al., 2017). Payne et al (2023) in her research at a hospital in Australia found that patients who required supporting examinations in CT scans required longer service times (Payne et al., 2023).

CONCLUSION

This study was conducted based on the ER's quality indicator achievement, service time ≤ 3 hours at St. Carolus Summarecon Serpong Hospital, which always does not reach the target (74,3% of the target > 90% of total ER inpatients). The results identified the root cause of problem originating from the stages of ER's patient transfer activities to the inpatient room which are consisted of 3 type activities: unplanned discharges of inpatients to cleaning service staff, the existence of room entrustment policies, waiting lists for VIP rooms and the lack of human resources for inpatient nurses. Post interventions using the DMAIC approach, the following results were obtained: lead time decreased from 4 hours 14 minutes to 2 hours 39 minutes 2 seconds, and non-value-added activities decreased from 1 hour 38 minutes 19 seconds to 32 minutes 22 seconds (↓ 67,1%). The following results were obtained at the control stage: lead time decreased from 2 hours 39 minutes 2 seconds to 2 hours 19 minutes 46 seconds, and non-value-added activities decreased from 32 minutes 22 seconds at the post-intervention stage to 25 minutes 23 seconds at the control stage (↓ 21,6%). The final result of the study in November 2023 obtained ER's service time achievement at St. Carolus Summarecon Serpong Hospital of 87,9% (↑ 13,6%). Researchers hope that with the DMAIC implementation and continuous monitoring and evaluation, the ER's service time will continue to improve and reach the target in the following month.

This study also produced several recommendations for St. Carolus Summarecon Serpong Hospital's management includes evaluation of 5S compliance, standardized work in the ER (as well as construction of ER laboratory), standard operational procedure for transferring ER's patients and standard for accepting new inpatients; one nurse standby at the inpatient nurse station and had a special time for changing rooms on the inpatient waiting lists; additional human resources for inpatient nurses and provide inpatient transit rooms; revision and review of hospital's bed information system. Some limitations when conducting this research include: Researchers have not been able to carry out interventions that require a long time, such as revising the hospital's bed information system, considering the limited research time and interventions carried out in the inpatient unit are limited to recommendations to those responsible for inpatient care. This research is based on the patient's perspective; thus, future researchers are expected to conduct research that discusses ER service time from the provider's perspective.

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