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Improving healthcare service processes by lean thinking

Sağlık hizmet süreçlerinin yalın düşünce aracılığıyla geliştirilmesi

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Abstract

Patients are getting in trouble with care processes due to waste and diversity in health care services. Although patients feel uncomfortable with these problems, service providers do not deal with their complaints promptly due to excessive workload and organizational disorder. The aim of this study is to implement lean techniques to solve the operational problems of a public hospital physical therapy and rehabilitation service in Eskisehir, Turkey. The process is analyzed both from the patient and service provider perspectives simultaneously in lean consumption context. Genchi gembutsu, value stream mapping (VSM), integrated consumption and provision map, A3 and heijunka were the lean techniques used. Mapping of the system gives the opportunity to relax the organizational complexity. Consequently, cognitive load of nurses is decreased with daily and weekly assignment algorithms designed as part of heijunka implementation. Also 26.84% of patient flow time and 14.28% of process step reduction are recorded as a result of realized improvements.

Keywords: Healthcare service, Lean thinking, Value stream mapping, Heijunka, A3

Öz

Hastalar sağlık hizmetlerindeki israf ve değişkenlik nedeniyle bakım süreçlerinde sorunlar yaşamaktadır. Hastaların bu problemler nedeniyle yaşadıkları rahatsızlığa rağmen, hizmet sağlayıcılar aşırı işyükü ve örgütsel kargaşa nedeniyle şikayetler ile ivedilikle ilgilenememektedir. Bu çalışmanın amacı Türkiye'de Eskişehir ilinde hizmet veren bir kamu hastanesinin Fizik Tedavi ve Rehabilitasyon servisinde yaşanan operasyonel problemlerin çözümünde yalın tekniklerin uygulanmasıdır. Süreç, yalın tüketim bağlamında hem hasta hem de hizmet sağlayıcı bakış açısından eş zamanlı olarak analiz edilmiştir. Genchi gembutsu, değer akış haritalama (DAH), bütünleşik tüketim ve tedarik haritası, A3 ve heijunka bu çalışma kapsamında kullanılan yalın tekniklerdir. Sistemin haritalandırılması örgütsel karmaşıklığın çözülmesi için fırsat sunmaktadır. Sonuç olarak, heijunka uygulaması kapsamında tasarlanan günlük ve haftalık atama algoritmaları ile hemşirelerin bilişsel yükü azaltılmıştır. Ayrıca gerçekleştirilen iyileştirmeler sonucunda hasta akış süresinde %26.84, süreç adımlarında ise %14.28 azalma kaydedilmiştir.

Anahtar kelimeler: Sağlık hizmeti, Yalın düşünce, Değer akış haritalama, Heijunka, A3

1 Introduction

Healthcare sector is a valuable area for production management research with high level variability, lack of standardization and need for process flexibility [1]. Patients are getting in trouble with care processes due to waste and deviations in health care services. Patients stay for long times in processes despite for short time value added care services. Researchers showed that the waste ratio is between 30-70% in healthcare [2]. Womack and Jones [3] define hospitals as "a world consisting of unrelated processes and waiting". Xie and Lawley [4] encourage to apply modern management techniques like lean management to cope with this kind of challenges in hospitals.

The origin of lean thinking is "Toyota Production System (TPS)". Muda, muri and mura are the core concepts in lean thinking. Muda (waste) defines activities that use sources but do not create value [3]. Muri is used for overburden and mura is used for unevenness or inconsistency [5]. Practitioners generally focus on "muda" because it is easy to define and eliminate [6]. Transportation, inventory, motion, waiting, over-processing, over-production and defects are the seven wastes [7]. Value, value stream, flow, pull and perfection are the five basic principles that are at the root of lean thinking [3]. Focus on patient, design care service according to patient, define value for patient, eliminate all other wastes and minimize the examination time are the five basic principles of lean for healthcare [8]. There are three kinds of activities in value stream analysis [3]: value adding, non-value adding and non-value adding but required. Value adding and non-value adding but required activities should be examined and improved; non-value adding activities should be eliminated.

Some hospitals started to use lean techniques in 1990's [5]. Mazzacato et al. [9] stated that emergency services are the most popular research areas in lean health implementations. 53% decrease in inventory level, 36% increase in efficiency, 41% decrease in space requirement, 65% decrease in supply time, 44% decrease in human movements and 82% decrease in set-up times were some of the gains in Virginia Mason hospital after 3-year implementation [10]. Lee et al. [11] showed the countermeasures and results in healthcare lean applications. Plytiuk et al. [12] found that there is an increase in papers about lean health after 2009 and theoretical papers doubles empirical papers. Jasti and Kodali [13] found that only 24.36% are empirical and only 3.67% are from healthcare sector according to lean production literature. They also established that only five papers are from Turkey. Surgery [14], orthopedics [1], ophthalmology [15] and radiologic oncology [16] are some of the implementation areas in the lean health literature. SMED [1], gemba [16], VSM [14],[16], spaghetti diagram [16], Kaizen [14],[16], A3 [17] are some of the lean techniques used in healthcare sector.

Graban [5] applied process re-design, 5S, visual management, standardized work, visual control, kanban lean techniques in a hospital laboratory and made an improvement in sample, personel and material flow. Vliet [15] explored relation between process design and efficiency in cataract pathways with lean perspective. Standardized work and SMED are the lean techniques used in Meredith's paper applied in 5 hospital's orthopedics operating theatre [1]. Simon [14] is the other researcher worked in orthopedics operating theatres. He gained 70 % decrease in procedure change and increase in patient satisfaction with process mapping and Kaizen techniques. A3 technique is used by Simons et al. [17] to reduce door movement in the operation theatres enhancing patient safety.

The benefits of lean thinking implementation in healthcare sector are shown in the literature [5],[8],[9],[12]. In spite of increasing popularity in lean healthcare, applicability and advantages have not shown exactly yet [9]. Moraros et. al. [18] also asserted the evidence to date simply does not support the claim that lean interventions lead to quality improvements in healthcare. Joosten et al. [19] reported that lean thinking has the potential to improve health care delivery but there is a resistance, limited usage of original lean tools and a lack of high quality evidence supporting lean premises. The findings of Hasle et al. [20] showed that lean in healthcare is the immature due to complexity of processes and health professions (doctor, nurse, manager), as well as their different value perceptions.

Liker [6] called attention that people and operation systems can suffer from this misunderstanding because activities that eliminates muda can cause muri and there will be a misperception about lean. He stressed to analyse muda, muri and mura together as a solution. Jasti and Kodali [13] stated that there is a need to use lean elements all together instead of taking of them as individual elements. The contribution of this study is to deal with the problem in an integrated way according to this suggestion. Appropriate lean tools are used from beginning till end of the study to this effect. To define the core problem of the system, the mapping stage and using A3 (lean problem solving tool) is very important. This study differs from other studies in using different mapping tools. To the best of our knowledge, Deniz and Ozcelik [21], is the first study based on "Integrated Consumption and Provision Map" in lean implementation. By the same token it is possible to detect the muda-muri-muras in lean consumption context by observing the process simultaneously from both customers and supplier perspectives [22]. Heijunka is selected as the lean tool to cope with mura detected in the process. There is only one case study assessed which implied heijunka in healthcare sector (ambulatory clinic-[23]) in the latest review about lean healthcare [24]. This study cannot be compared with this study because of the implementation area (a clinic) and methodology (they did not did not draw VSM, did not define muda and did not arrange the system according to takt time).

The remainder of this paper is organized as follows. Section 2 describes materials and methods used in this paper. Section 3 analyzes the results and makes a discussion. Conclusions are given in Section 4.

2 Material and methods

2.1 Setting

The case study to implement lean thinking principles is conducted in a public hospital's "Physical Therapy and Rehabilitation Unit (PTRU)" in Eskisehir, Turkey. The study is held in May 2015. This hospital offers service with 334 beds in 57.000 m^2 space. There are approximately 200 physicians working in 34 different branches in that hospital. PTRU, is focused on physical therapy service given by five nurses, eleven cabins and an exercise area. There are TENS (Transcutaneous Electrical Nerve Stimulation), hot pack, ultraviolet, infrared, paraffin bath, radar and short wave diathermy equipment in those cabins. Cabin 1, cabin 2 and cabin 3 are different from the other cabins because of the radar and short wave diathermy machine's technical properties. They cannot be placed next to other equipment due to these properties. One nurse is responsible for these three cabins. The other eight cabins are equally distributed amongst 4 nurses (2 cabins/nurse). Treatment time is fixed by Turkish Ministry of Health as "one hour".

Lean implementations of this study, to improve the performance of the system, are achieved in four phases as: Mapping the current system, A3 implementation, process re-design and heijunka implementation.

2.1.1 Phase 1: mapping the current system

In the first step of the study data is collected to map the system. "Genchi gembutsu" (a lean technique based on to see the work in the gemba (where the work is done exactly and the value is generated)) [22]. For this purpose, researcher made observations to collect the data in the gemba according to Ohno's suggestions [5]. Outpatient waiting area, polyclinic, PTRU waiting area, PTRU service area and therapy cabins are the gemba points. Observation instances are determined to enable to perceive the whole process steps in different times during a service day. Collected data is used to draw process diagrams in the next step of the study. Process diagrams are generated including all patient families to be base for value stream maps (VSM). At this stage observing the whole process beginning from the entrance of the patient into PTRU polyclinic to the last session of the therapy is aimed.

Current and future states of the system can be visualized by VSM as a commonly used lean technique. Defining product family, documenting current state, designing future state and developing an implementation plan to attain future state are the steps of VSM systematic process [25]. Patient family consists of patients who are decided to get Physical Therapy and Rehabilitation sessions after examination is selected in this study because of the late appointment times (nearly 3 months) for starting Physical Therapy and Rehabilitation sessions. Current VSM-the backbone of the lean implementation- can be seen in Figure 1. "Process Mapping" [7] and "Integrated Consumption and Provision Map" [22] are the other mapping tools, used to analyze patient consumption process in this research. Hines [7] suggested to use "Process Mapping" to list all action steps in the process whether they are value-adding or non-value adding activities (Table 1). Womack ve Jones [22] introduced a new lean mapping tool in lean consumption context in their last book "Lean Solutions".

In "Integrated Consumption and Provision Map", "Lean Consumption" and "Lean Provision" maps are drawn simultaneously to see the process in holistic way from both

perspectives- customers and supplier. Customers activities are located in the upper side of the map and supplier activites are in the lower side. Box lenghts are proportional with the time required for that action. Value-added actions are shaded to stress. Dashed lines represent the appointment activity. "Integrated Consumption and Provision Map" can be seen in the Figure 2.

Table 1: Process mapping adopted from Hines (2002).

	Unit	Action Step	Time (min.)	Concerning Personel	Action Type		
					Value adding	Non-value adding	Non-value adding-required
1	PTR Polyclinic	Entrance procedure	2	Polyclinic Secretary			√
2		Waiting	5	-		√	
3		Examination	10	Physician	√		
4		Exit procedure	2	Poly. Secr.		√	
5	PTR Unit	Appointment procedure	5	Unit Secr.			√
		Waiting*	148320	-		√	
6		First session Entrance procedure	2	Unit Secr.			√
7	PTR Polyclinic	Entrance procedure	2	Poly. Secr.			√
8		Waiting	10	-		√	
9		Examination	5	Physician	√		
10	PTR Unit	First session Report procedure	5	Unit Secr.			√
11	Physician	Physician approval of the report	10	Physician		√	
12	Medical Superintendent (MS)	Medical Superintendent (MS) approval of the report	30	MS Affirmative Authority		√	
13	PTR Unit**	Session entrance	1				√
14		Treatment	60	Nurse	√		
		Waiting***	1440	-			√
		Total Time Spent By Patient (min):			149		
		Value-adding Time(min):			75		
		Total Step Number:			14		

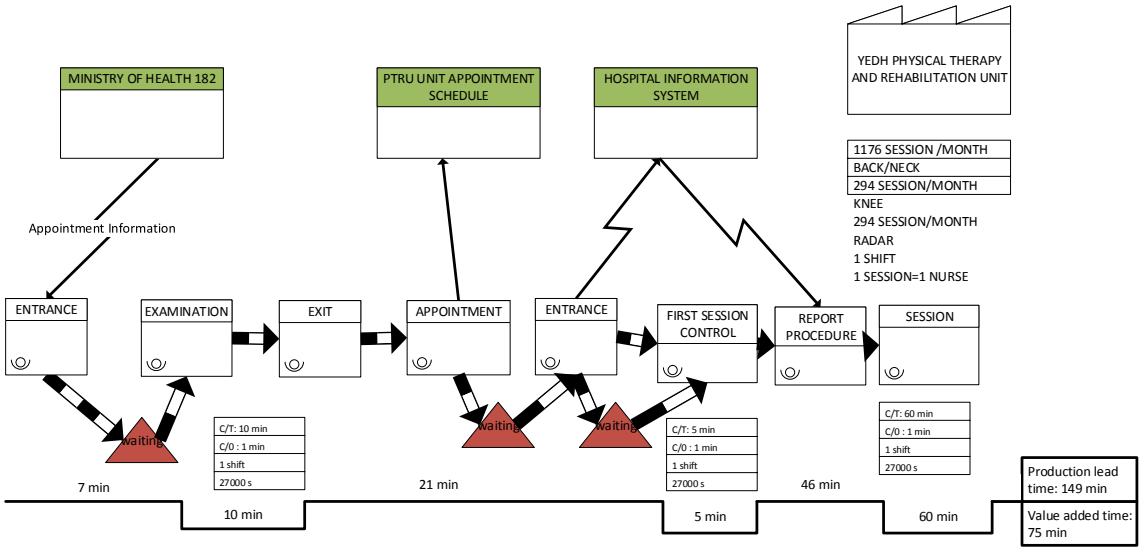


Figure 1: Current value stream map (April 2015).

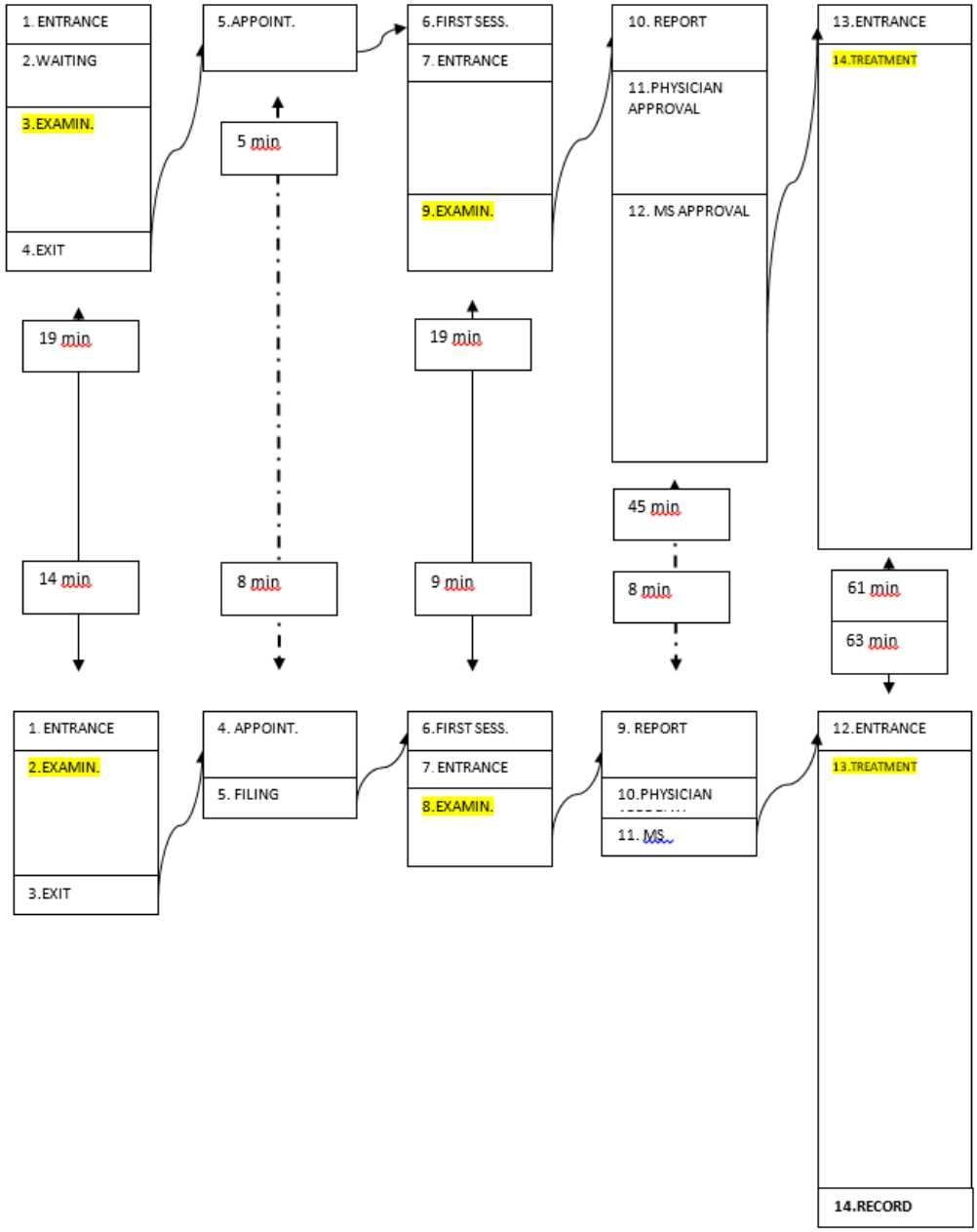


Figure 2: Integrated consumption and provision map (April 2015).

2.1.2 Phase 2: A3 implementation

A3 is a visual version of Deming's Plan-Do-Check-Act cycle. Problem, background, current condition, goal, proposal, plan and follow activities are written only on a A3 size paper. This A3 report is hanged up a point where all staff related with this process can see [22]. A3 problem solving process is systematized by Graban in five steps [5]:

- Go to gemba,
- Talk with staff in the process,
- Attain the root cause beyond cursory problems,
- Look at the cross-border of the service and value stream,
- Improve processes before spending money for growing and capital.

A Kaizen meeting is made in the gemba with the participation of director, nurses, physiotherapists and the secretary based on non-value adding activities in current VSM. Rother and Schook [25], focused on patient demand, flow and smoothing to draw the future state VSM. The need to shorten the waiting time before first session of therapy is stressed by the PTRU director. Secretary also gave information from patient's perspective that they are excessively complaint about this problem. Aggregation in waist and neck patients was the additional information given by secretary. PTR is a long-term treatment between 10-20 days.

The problem emphasized by nurses was the misperception of patients when they get therapy from different nurses and in different cabins. Patients compare the treatments made by different nurses and this caused lack of confidence in patients. This problem (treatment instability) is analyzed with A3 as per LEI (2010) template (Figure 3). Taichi Ohno used "Five Why" method in the third step of the process to see the root cause of the problem with asking "Why?" question iteratively five times [22]. The first question in "5 Why" context is "Why the patients are get therapy from different nurses each day?" The answer is that the current system is designed for justice. In this system, a nurse is responsible for cabins 1, 2 and 3. Assigning the patients to the other eight cabins (4-11) is the second task of this nurse. Consequently, these eight cabins are evenly distributed amongst the four nurses. This assignment is valid for a week. At the beginning of each hour, patients are assigned to cabins randomly. Distribution of equal number of patients to each nurse is the primary aim.

The second question is "Why is it unfair to assign the patient always to the same nurse?" The reason is that some patients do not get there to some of the sessions and nurses do not attend to work each day. Thus, the main problem of the system is recognized as instability. The next question is how the instability causes injustice. Assigning patients with ignoring this instability is the reason. After this analysis heijunka is selected to cope with detected mura.

2.1.3 Phase 3: process Re-design

In the "focusing on flow" stage in drawing the future state VSM, patient consumption process was analyzed. Process steps analyzed by using current VSM, "Integrated Consumption and Provision Map" [21] and "Process Mapping" [7]. Patients spend 149 minutes (75 minutes' value added) in 14 steps alongside service providers spend 102 minutes in 14 steps to generate this value (Table 2). Elimination of 2nd, 4th, 8th, 9th, 11th, and 12th patient steps in future value stream map is aimed. A patient's sojourn time will be 87 minutes in 8 steps as it can be seen Table 2. Also 3th, 11th, and 12th steps of service provider are planned to eliminate for a 97 minutes' service time in 11 steps. In this research only 11th step on approval of the report by physician and 12th step on approval of the report by Medical Supervisor were eliminated. By this way a 26.84% improvement is recorded in flow time.

2.1.4 Phase 4: heijunka implementation

The demand instability which was depicted in A3 meeting is undertaken in the "focusing on smoothing" stage in generating future state VSM. TPS's corner stone heijunka is defined as "production levelling in both volume and product mix" [26]. As a strategy in eliminating mura, heijunka deals with smoothing daily fluctuations in total order and generating a "balanced program" consistent with long term order [3]. Jones [27] stress that heijunka has a critical importance in a lean system because of its key role in maintaining stability. Lean producer has AABCDAABCD sequence instead of mass producer's scale economy based AAAABBCCDD sequence in production scheduling [27]. The term, "takt time" is used in lean literature for cycle time and it is an important parameter in heijunka implementation.

Takt time is also an indicator that indicates the rate of the process to reach one-piece flow. Takt time is calculated by dividing the current production time to demand [10]. Working time in PTU is 7 hours (420 minutes) between 08:00-12:00 and 13:00-16:00. Appointments are determined at the beginning of each hour in the current process (7 session/cabin*8 cabin/day=56 sessions/day). In addition, KDD and radar patient capacity is 14 sessions per day. No demand data was available to calculate takt time because of the appointment records are written in a notebook manually. Patients are not recorded by a computer system until the first session is started. Therefore, data is collected in different days and different time intervals to represent the reality. Demand data is obtained as 62,9 sessions/day for cabins 4-11 and 36.4 sessions/day for cabins 1-3.

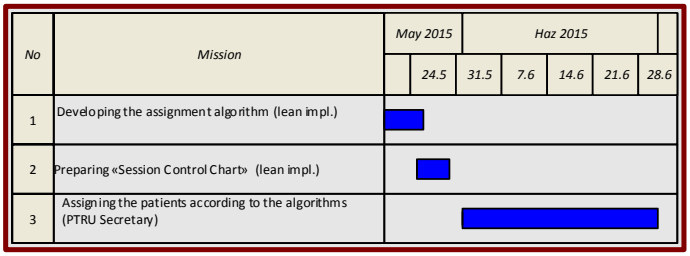
<table>
<tr><td>Problem Name: Distrust experienced by patients</td><td>Unit: Physical Therapy and Rehabilitation Unit (PTRU)</td></tr>
<tr><td>Background: PTRU working system depends on cabin system. A nurse is responsible for two cabins in this system. Patients are assigned to cabins randomly at the beginning of the hour. Consequently a patient can get theraphy form different nurses in different cabins during the treatment period.</td><td>Proposal:
To develop an assignment algorithm which takes instability into account
Preparing a "Session Control Chart"
Making assignment according to the algorithm.</td></tr>
<tr><td>Current Conditions: Patients are distributing to the cabins according to the types in the current condition. Back and neck patients are distributed to cabins 4-11 randomly. Cabin 1 and 3 is for short wave diaterm patients and cabin 2 and 3 is for radar patients.</td><td rowspan="2">Plan:
 
</td></tr>
<tr><td>Goal: To design an algorithm based on assigning the patient according to the same cabin and nurse each session.</td></tr>
<tr><td>Analysis: Patients get therapy from different nurse each session day. WHY? Patients are assigned based on current cabin system. WHY?
It is aimed to prevent inequality. WHY?
Patients and nurses may not come sessions. WHY THIS CAUSE INEQUALITY?
There isn't any algorithm taking into consideration of instability.</td><td>Follow up:
Patient opinions
Nurse opinions
Session numbers</td></tr>
</table>

Figure 3: A3 problem solving report.

Table 2: Process steps of patient and service provider.

No	Process Step	Current Time (min)	Proposed Time (min)	Process Step	Current Time (min)	Proposed Time (min)
1	Entrance procedure	2	2	Entrance procedure	2	2
2	Waiting	5		Examination	10	10
3	Examination	10	10	Exit procedure	2	
4	Exit procedure	2		Appointment procedure	5	5
5	Appointment procedure	5	5	Filling the Session Control Table	3	3
6	First session entrance procedure	2	2	First session entrance procedure	2	2
7	Entrance procedure	2	2	Entrance procedure	2	2
8	Waiting	10		Examination	5	5
9	Examination	5	5	First session report procedure	5	5
10	First session report procedure	5		Physician approval of the report	1	
11	Physician approval of the report	10		Medical Superintendent (MS) approval	2	
12	Medical Superintendent (MS) approval	30		Session entrance procedure	1	1
13	Session entrance procedure	1	1	Giving treatment	60	60
14	Getting treatment	60	60	Recording the session information	2	2
Total Time Spent by Patient (min):		149	87	**Total Time Spent by Service Provider**:	102	97
Value-adding Time(min):		75	75	**Value-adding Time**:	75	75
Total Step Number:		14	8	**Total Step Number**:	14	11

Consequently, takt time for 1st group (cabins 4-11):

$$(420\ min/day / 62.9\ sessions/day = 6.68\ min/session) \quad (1)$$

and takt time for 2nd group (cabins 1-3):

$$(420\ min/day / 36.4\ sessions/day = 11.5\ min/session) \quad (2)$$

Because of the session time for each patient is 1 hour (60 minutes), number of patients should be

$$60/60.8 = 8.98 \text{ 1st group patient/hour} \quad (3)$$

$$60/11.5 = 5.21 \text{ 1st group patient/hour} \quad (4)$$

However, the number of patients are 8 and 4, in the current situation. This means there is an unmet demand and a bottleneck. Pacemaker process (process that determines the pace in which scheduling is made) is the appointment process in the current VSM.

In the "focusing on patient demand" stage in drawing the future state VSM (Figure 4), interviews were made with patients who are waiting before the session, who are in the treatment cabins and whose treatment is finished. They didn't give any negative feedback except the long appointment time before the first session of the therapy.

Increasing daily capacity is not an alternative because of the impossibility in increasing nurse and cabin numbers. Therapy time is also fixed by Ministry of Health as "1 hour". After analyzing of this "1 hour" period, its two phase nature as electrotherapy and exercise is recognized. The electrotherapy has given by nurse in cabins and it takes maximum 45 minutes. Exercise part of the therapy has given by physiotherapists in exercise area and it takes minimum 15 minutes. This means that at least 15 minutes is idle time for cabins. This information gives us an alternative to shorten the therapy times from 1 hour to 45 minutes. By this way, session capacity in a day is increased from 56 to 72 (28.57%).

Variability sources are analyzed after takt time determination. These sources are classified as patient or nurse related as depicted as follows.

- ✓ Patients related
  - Patients do not come to the first session
    - Patients can go private hospital instead of waiting
    - Patients can forget the appointment day
    - Patients can die
  - Patients do not come to the ongoing sessions
    - Patients can be ill
    - Patients can forgo
    - Patients can have important works
- ✓ Patient's therapy can be extended by the physician after the last session examination
- ✓ Nurses related
  - Nurses need to be on guard in hospital
  - Nurses can be ill
  - Nurses can be on vacation

As indicated by data collected on Mondays in May 2015, approximately 50% of new patients do not come, 5 patients per day do not come ongoing sessions, only one patient got additional session (can be ignored), 6 nurse guards in the May guard schedule (1-1-3-1 each week).

The best way in lean thinking is manual working if possible, before technology assistance [10]. According to this advice, a "Session Control Chart" (Figure 5a) is designed as a heijunka board for PTRU. Hanging up of this chart on the cabin wall to be

seen both patients and nurses is intended. This chart can be seen as a visual control also. In the current situation, patients are assigned to cabins and nurses randomly. It is planned to make schedule by using of weekly and daily based algorithms developed in this research (Figure 5b and 5c). Assigning in a systematic way to ensure equality between nurses and to increase the patient satisfaction level is aimed. The filling priority is the left and upper cell in this chart. Weekly assignment algorithm is important to detect the patients who will not start the sessions. Assigning the patient to the same nurse and cabin is an important change in the proposed system. The equality between nurses will be ensured by daily assignment algorithms. The backbone of this scheduling algorithm is calling the new patients one week before the appointed first session. First of all, to make a shift between cabins after neither one nor two weeks' period is recommended. Because it was found that 80.95% of patients get 10 days' session.

It is suggested to classify patients as lying (L), sitting (S), short wave diathermy (W) and radar (R) patients. Demand numbers is also an unrecorded data. In this research, this data is collected and used to determine the appointment numbers. It is planned to give 4 date for L type patients, 4 date for S, 2 date for W and 2 date for R. These patients are planned to assign cabins WRW(R)LSLSLSLS consecutively.

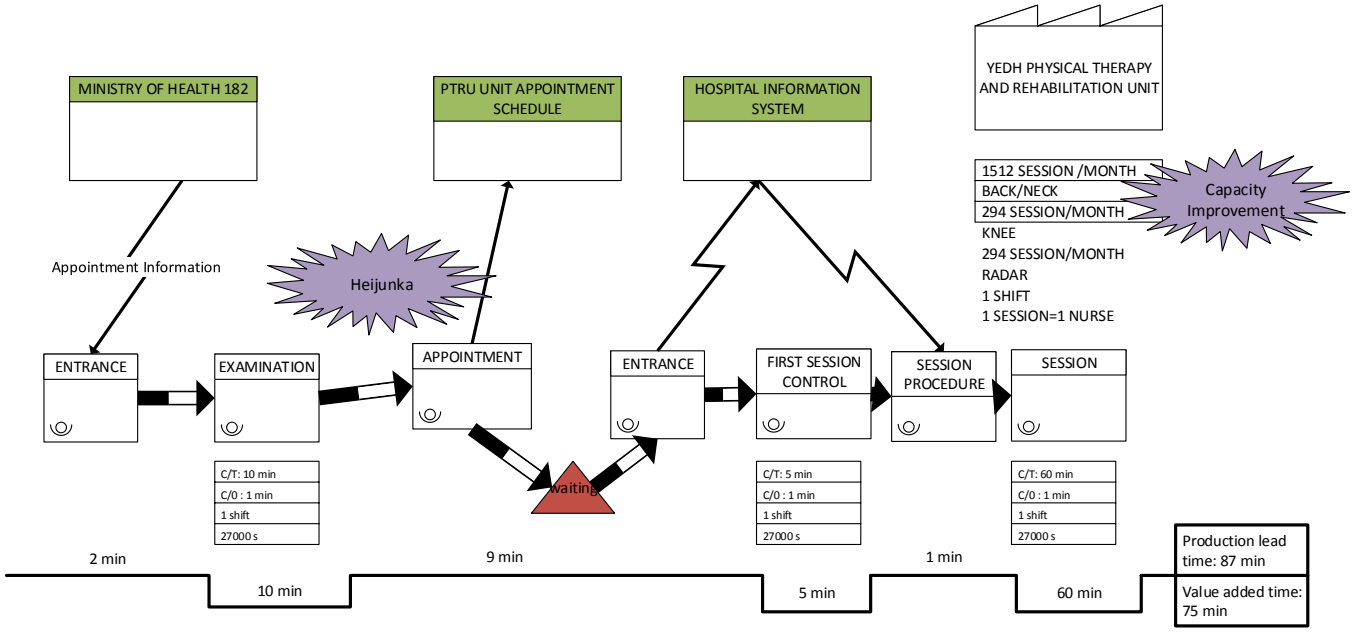


Figure 4: Future Value Stream Map (May 2015).

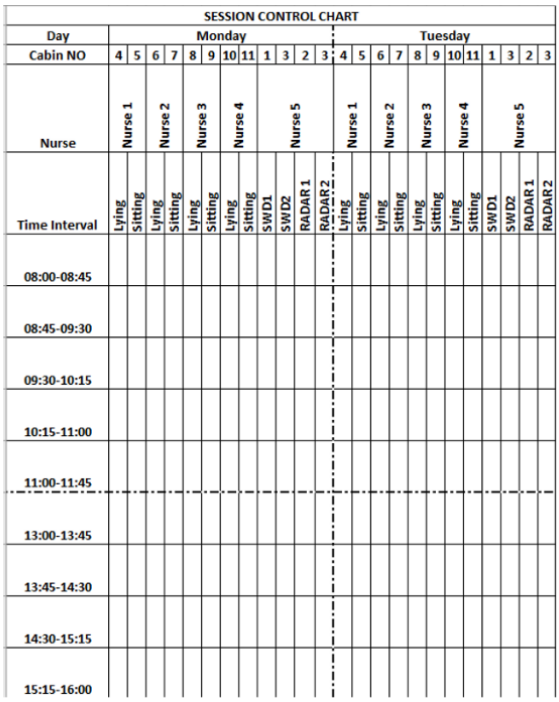


Figure 5(a): A part of session control chart.

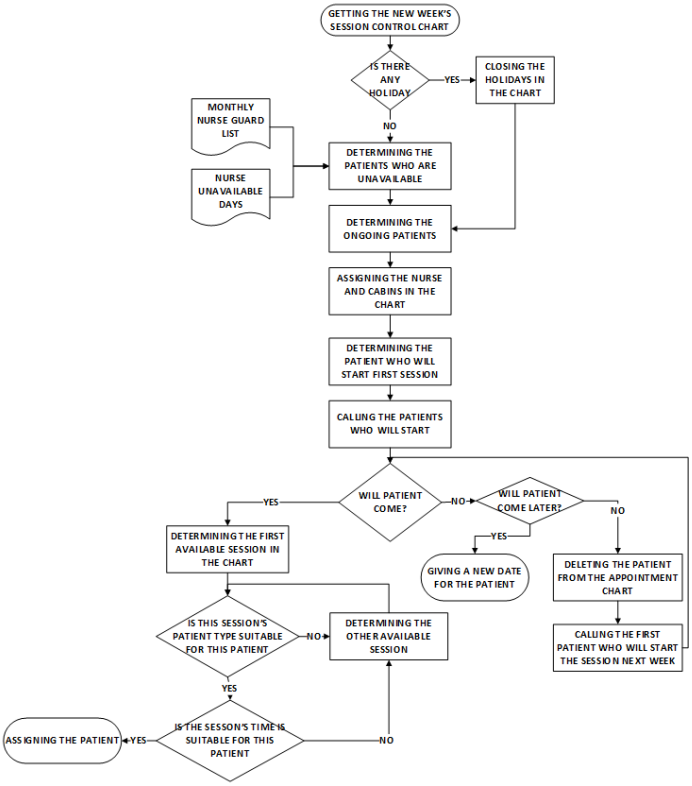


Figure 5(b): Weekly assignment algorithm.

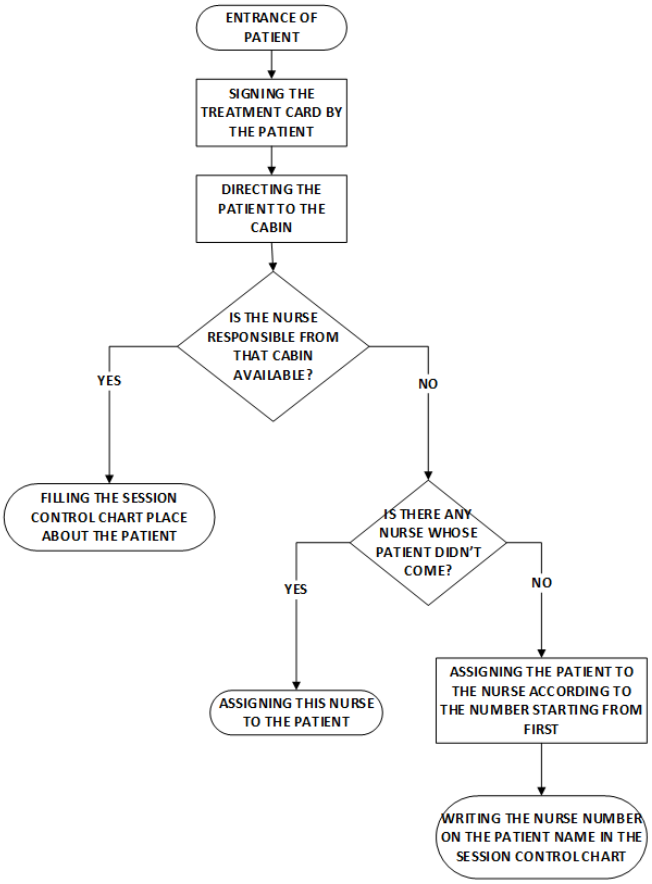


Figure 5(c): Daily assignment algorithm.

3 Results and discussion

In this study, lean techniques as genchi gembutsu, mapping process diagram, value stream mapping, process mapping, integrated consumption and provision mapping), heijunka and A3 are implemented in a public hospital's Physical Therapy and Rehabilitation Unit. The ultimate ideal situation -expected in the case of full support by top management- is not achieved by this research due to the lack of high authority support. In Table 3, both of the results (achieved and ideal) can be seen.

The accumulated number of patients in 3 months and 10 days can be reduced in approximately in 50 weeks with the capacity improvement (640 session/month). These results show that the system can process according to one-piece flow in a year with the current 7 cabins.

4 Conclusion

In this paper a lean implementation was started in a public hospital Physical and Therapy Unit. Genchi gembutsu, value stream mapping (process diagram, process mapping, integrated consumption and provision mapping), heijunka and A3 techniques were used in this concept. To the best of our knowledge it is the first study that used "Integrated Consumption and Provision Map" and "process mapping" with VSM and applied heijunka with A3 in healthcare sector. This study differs from other lean implementations in healthcare by its holistic perspective. Suitable lean tools are used in all phases of the implementation.

Eliminating process steps has an evident effect on reducing over-processing, transport, waiting, and motion type wastes. Patient flow time is decreased by this way. Waiting type muda is reduced with capacity improvement. Mura is reduced with heijunka. Transport and waiting type muras are reduced with the calling patients before the first session. In addition, visual control activities are helpful in coping with motion type mura. Activities to achieve one-piece flow are related with the waiting type mura. These results show that lean solutions are effective tools in solving efficiency problems in healthcare sector. This study also demonstrates a road map for healthcare staff. The main point of the implementation is each institution should determine the right technique in lean toolkit to eliminate muda-muri and mura together. Mapping the system gave us opportunity to relax the organizational complexity. The nurse's cognitive load is decreased with daily and weekly assignments developed.

This paper shows the benefits of using lean production techniques in healthcare concept. To reach the ideal solution a system must be handled in a holistic way. The results of the study are valuable for both academicians and healthcare staff. Academicians can see the theoretical applications of lean techniques in healthcare context. Healthcare managers can use these lean techniques and start a lean journey in their hospitals.

Staff expressed reservations about scheduling period decrease from 60 to 45 minutes in terms of set-up times in the discussion about proposed system's applicability. This problem can be solved with another lean technique SMED. A resistance to change is observed according to these ideas of staff. Some changes could not have done, lack of the high authority support. These experiences are consistent with Young and McClean [28] who stated evidence, value and metrics are the challenges about lean thinking in healthcare.

Cross-sectional data is used because of the ethic limitations in video records usage. The absence of some of the essential data is another problem. This research is conducted in only a small part of the hospital whether lean transformation needs a holistic application. High authority need for changes and staff involvement is very important at this stage. Resistance for change is another problem especially in public sector.

Daily and weekly assignment algorithms can be coded in Excel VBA, C, etc. to make the process easier. 5S lean technique can be used to make a base for other lean techniques also. Kaizen meetings should be make periodically to make the lean implementation sustainable. Visual control lean technique can be used to make the monitoring the process easily. Shojinka lean technique can be used to balance work-loads of nurses after starting to use the "Session Control Chart". Analysis will be done in detail if longitudinal data can be collected. VSM can be enhanced via simulation [29],[30]. The new VSM approach proposed by Henrique et al. for healthcare environments can be used in mapping phase [31]. ErgoVSM [32] which was generated for manufacturing with the aim of integrating VSM and ergonomics, can be adopted for service industries and healthcare sector.

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Table 3: Results table.

Performance Criteria	Achieved Results			Ideal Situation		
	Before	After	Imp. Ratio%	Before	After	Imp. Ratio%
Flow time (patient)	149	109	26.84	149	87	41.61
Flow time (service provider)	102	99	2.94	102	97	4.90
Process Step Number (patient)	14	12	14.28	14	8	42.85
Process Step Number (service provider)	14	12	14.28	14	11	21.42
Total Daily session				56	72	28.58

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