LEAN HEALTHCARE IMPLEMENTATION IN MALAYSIAN SPECIALIST HOSPITALS: CHALLENGES AND PERFORMANCE EVALUATION

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Abstract

Hospital overcrowding is a major issue in Malaysia which has led to increased patient waiting times. Lean healthcare initiative, which focuses on identifying and eliminating non-value-added activities in work processes, was introduced by the government to tackle congestion by improving day-to-day work efficiency while optimising the use of resources at Emergency Departments and Medical Wards. This paper reports on Lean initiatives applied in major and minor specialist hospitals, their performances and challenges faced. Performances of 36 major and minor specialist Ministry of Health hospitals were analysed using four outcome variables: arrival to consultation (ATC), length of stay (LOS), bed waiting time (BWT) and discharge time (DT). The median difference in minutes between pre- and post-Lean implementation at six months and one year, as well as post-Lean at six months and one-year implementation, were compared using the Wilcoxon-Signed Ranks Test. Significant time reduction ($p<0.05$) was evident in DT for both major and minor specialist hospitals post six months and one year of Lean implementation. For BWT and LOS, significant reduction was seen only in major specialist hospitals post six months and post one year, respectively. There was no significant time reduction in ATC for both major and minor specialist hospitals. The results indicated that Lean healthcare is important. However, it is not the sole determinant for measuring the hospitals' performance; other challenges including different departments' silo mentality, staff's resistance to change, financial constraints and IT system, also play important roles in Lean implementation.

Keywords: Hospital, Overcrowding, Healthcare, Lean, Waiting Time

Introduction

The Lean initiative is a philosophy which originated from the Toyota Production System (TPS). It was developed by Toyota's manager Mr Taichii Ohno, whose focus was on improving the work process and enhancing the quality of its services. The concept was derived from Graban, 2016 (1). It is a set of concepts, tools and principles, used to create the best service in order to offer customers high value for their money while consuming the least resources, whilst optimising the knowledge and skills of the workers. The Lean initiative has been widely implemented in manufacturing sites and focuses on eliminating non-value-added activities to facilitate the work process. Following promising results seen in manufacturing sites, the Lean initiative has spread widely to other sectors, including healthcare and management, since the 1990s.

The issue of overcrowding and congestion in public hospitals in Malaysia has always been the focus of the Ministry of Health (MOH). The issue is not new, since it is also noted globally (2-5). Some reported factors

contributing to overcrowding in hospitals, especially in the emergency departments (ED), are prolonged waiting time, delayed treatment, high occupancy, access blocks, large patient influx coming to ED, and hospital readmission (6). As a measure to alleviate the situation which affects the delivery of care for patients, various strategies have been implemented.

One of the government's initiatives to overcome this rising issue of congestion, was the introduction of the Lean initiative to improve efficiency of the day-to-day work whilst minimising costs and resources. It was first implemented in 2013 in a major specialist hospital in the southern region of Peninsular Malaysia; it was one of six pilot hospitals aiming to reduce patients' waiting time in seeing doctors at orthopaedic specialist clinics. Interestingly, the results showed a significant reduction (46%) in waiting time; from 115 min to 62 min (7, 8). The success has led to the expansion of the Lean healthcare concept to other MOH hospitals including state hospitals, major and minor specialist hospitals.

This paper aims to highlight the stages of Lean implementation in major and minor specialist hospitals, challenges faced and to evaluate hospitals' performances pre- and post-Lean implementation at six months and one year. The performance of each hospital were not compared against each other as each hospital's kaizen and implementation method are unique to the hospital.

Materials and Methods

Lean training framework

Lean framework (Figure 1) was applied to various hospitals (n=36), which were major and minor specialists' hospitals. In 2016, 16 major specialists' hospitals were chosen and 20 more minor specialists' hospitals were added in 2017. The selection of these hospitals were made by the stakeholder, i.e., the Medical Development Division, based on the high number of patients' attendances and high bed occupancy rate. The demographic information of these 36 hospitals is presented in Table 1.

Hospital backgrounds

The 36 major and minor specialist hospitals within MOH are located throughout the country, in Peninsular and East Malaysia (Table 1). The hospitals were categorized into major and minor specialist hospitals according to the total number of beds available per year in the hospitals. These hospitals received an average of 79,513 visits annually to the EDs (95% CI 69,170 to 89,857) and 17 admissions to the medical wards (MW), on a daily basis (95% CI 14 to 20). With a capacity for more than 700 beds, these hospitals have become the referral centre for patients' treatment. As the population increases, these hospitals face a major increase in the number of patients being treated at their facilities which eventually led to overcrowding and

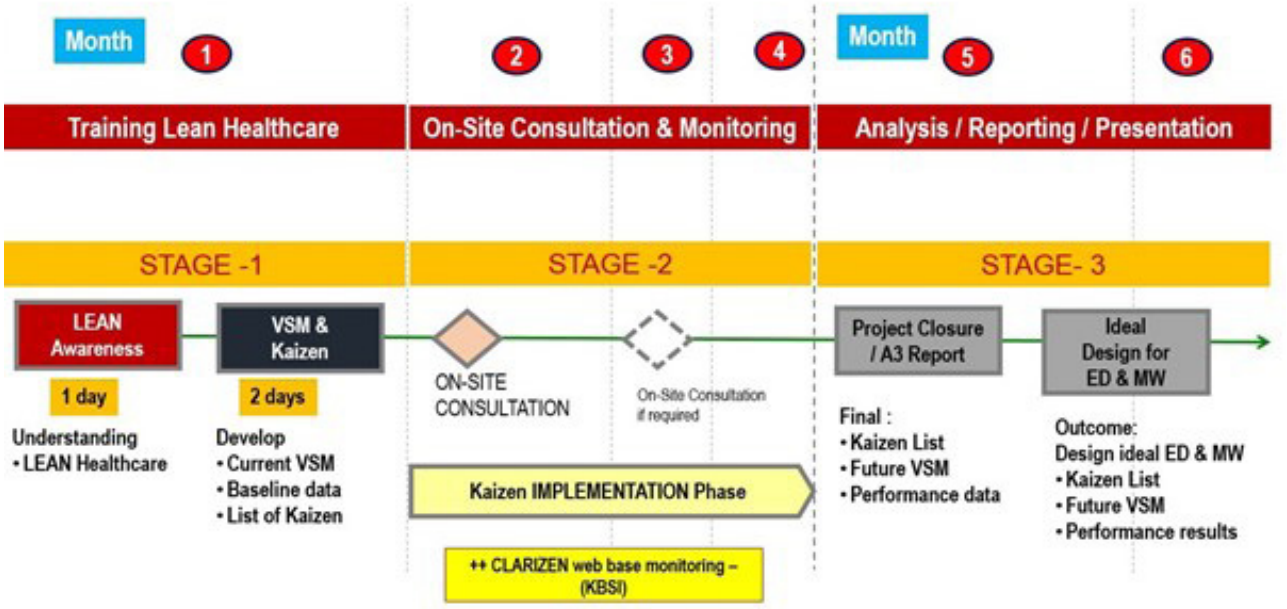

Figure 1: Lean Healthcare framework implementation. Visual Stream Mapping (VSM) is a Lean management tool that helps visualize the steps needed to take from product/service creation to delivering it to the end-customer. Kaizen Burst Status Indicator (KBSI) is a tracking tool used to monitor progress of kaizen implementation

Table 1: Hospitals' demography

Hospital	Type of hospital	Total beds per year	Attendance to ED per year	Admission hospital per year	Average Admission GM per day	No. of hospital discharges per year	Average Discharge GM per day*	No. of specialties in hospital	No. of staff in ED	No. of staff in MW
H1	Major specialist	400	78979	4367	11.93	4348	11.91	15	98	144
H2	Major specialist	314	54806	8455	23.1	8479	23.23	13	74	89
H3	Major specialist	292	58023	5213	14.24	5232	14.33	10	75	94
H4	Major specialist	630	68971	8452	23.09	8548	23.42	17	38	194
H5	Major specialist	401	109876	4375	11.95	4388	12.02	12	130	118
H6	Major specialist	694	129146	6227	17.01	8182	22.42	34	206	173
H7	Major specialist	562	120462	9499	25.95	8777	24.05	24	148	417
H8	Major specialist	326	115727	7687	21.00	7432	20.36	13	116	132
H9	Major specialist	314	55177	6782	18.53	6566	17.99	16	102	123
H10	Major specialist	172	38067	2665	7.28	2983	8.17	14	N/A	47
H11	Major specialist	133	51221	3160	8.63	3264	8.94	12	65	34
H12	Major specialist	150	58407	4490	12.27	4489	12.29	13	N/A	N/A
H13	Major specialist	650	101649	10266	28.05	10297	28.21	18	169	N/A
H14	State hospital	408	99638	10713	29.27	10722	29.38	25	112	216
H15	Major specialist	628	122583	6985	19.08	12053	33.02	24	N/A	N/A
H16	Major specialist	350	104113	6316	17.26	6141	16.82	15	N/A	135
H17	Major specialist	608	101849	12689	34.67	13302	36.44	24	127	417
H18	Major specialist	393	100263	7820	21.37	7582	20.77	20	139	180
H19	Major specialist	400	23166	3705	10.12	3726	10.21	6	109	133
H20	Major specialist	345	64784	4859	13.80	4733	12.97	15	N/A	143
H21	Major specialist	516	111489	12743	34.82	12440	34.08	16	99	N/A
H22	Major specialist	550	89117	7169	19.59	12899	35.34	18	95	212
H23	Major specialist	704	110349	10328	28.22	9613	26.34	35	118	N/A
H24	Major specialist	548	85278	8899	24.31	9098	24.92	18	114	N/A
H25	Minor specialist	155	76461	3838	10.49	4048	11.09	5	45	67
H26	Minor specialist	242	73843	7175	19.60	7222	19.79	5	74	97
H27	Minor specialist	134	28399	1891	5.17	1960	5.37	2	45	51
H28	Minor specialist	96	29510	2174	5.94	2159	5.92	2	55	59
H29	Minor specialist	305	116509	6908	18.87	7040	19.29	11	91	149
H30	Minor specialist	212	88538	4165	11.38	4174	11.44	10	78	N/A
H31	Minor specialist	108	55759	5137	14.04	5091	13.95	6	N/A	N/A
H32	Minor specialist	268	123751	8371	22.87	8408	23.04	9	111	88
H33	Minor specialist	268	49893	1920	5.25	1987	5.44	9	59	56
H34	Minor specialist	110	59030	2474	6.76	2639	7.23	3	62	69
H35	Minor specialist	113	60074	3830	10.46	3800	10.41	8	77	N/A
H36	Minor specialist	110	47581	1984	5.42	1918	5.25	7	59	N/A

ED: emergency department
GM: General Medicine
H: hospital
MW: medical ward
N/A: not available

congestion, both at EDs and MWs. In fact, according to statistics, hospitals in Malaysia received approximately 2,510,438 admissions for the year 2017 (9).

The implementation of Lean framework was done in three stages. Stage 1: Training on Lean Healthcare, Stage 2: On-Site Consultation and Monitoring, and Stage 3: Analysis, Reporting and Presentation to Stakeholders. The hospital

personnel involved in the implementation were given a three-day training on Lean thinking, development of Value Stream Mapping (VSM) and *kaizen* generation (Japanese term for ideas of improvement). The training involved multilevel staff ranging from management to support staff, including medical officers, assistant medical officers, nurses, administrative staff, and top-level managerial staff.

Following the training, the hospitals started implementing Lean. During stage 2, the hospitals were visited by facilitators and Lean trainers from the Ministry of Health and National Institutes of Health for on-site consultations, based on the progress. The facilitators evaluated the respective hospitals' performance and provided technical advice for improvement. The hospitals' *kaizen* progresses were monitored concurrently using a web-based programme called "Clarizen". The persons-in-charge of Lean initiative in these hospitals were given ID numbers to login and update the progresses. The activities of these hospitals were monitored in real-time and were available to be accessed by hospital directors and the relevant stakeholders.

Following implementation, as a means of measuring improvements, hospitals were required to conduct post-lean data collection and analysis. Data were collected twice after the implementation to determine whether the staff would become more familiar and fully-adapted with the *kaizens* if given more time. The implementation of the Lean initiative was concluded with a project closure report in an A3 report format. This one-piece of A3 report documented all the improvements made, from the start of Lean initiative until six months after its commencement. The A3 report can be shared with staff and patients on the information board or the "Lean initiative" corner. In order to ensure the sustainability of the programme, regular monitoring is crucial. Therefore, hospitals were encouraged to conduct data collection twice per year as well as to report their performances to stakeholders.

Data collection

Based on the Malaysian Triage Category (MTC) system, EDs were divided according to clinical zones and patients were triaged into zones based on the severity of their illnesses. The red zone is for critical cases, yellow is for semi critical cases while green is for non-critical cases. When patient load in the three zones were compared, the highest patient load was seen in the green zone, contributing between 60-70% of the total number of patients (10). Since the bulk of the patients was from the green zone, the focus of this study is on the green zone.

Further data collection in the green zone was done using a universal sampling method, where all patients who visited the green zones in ED over a period of seven days, were recorded. As for bed waiting time, all cases from the ED's green, yellow and red zones were taken as samples. In the case of medical wards, discharge time was based on the mean duration patients were discharged from the general medical wards. Data collection was done over a period of one year to evaluate the sustainability of the *kaizens*. Hospital staff were required to collect the data using a pre-defined format. Among the variables indicated were "date and time of arrival to triage", "date and time of consultation with doctor", "date and time of discharge", and "date and time patient from ED arrived at the MW bed". As for the MWs, the variables recorded included "date and time being discharged home" by physician, "date and time patient left bed" after its occupancy, and "date and time bed was ready for the next patient". The data were keyed into a standard template in Microsoft Excel version 2013. The data was verified for completeness and accuracy by team from National Institutes of Health.

Outcome variables

Four main outcome variables were investigated in the EDs and MWs: 1) arrival to consultation (ATC), 2) length of stay (LOS), 3) bed waiting time (BWT), and, 4) discharge time (DT). The definition and calculation for each of the variables are presented in Table 2.

Table 2: Definition and calculation of outcome variable for Lean implementation at emergency departments (ED) and medical wards (MW)

Outcome variable	Definition	Calculation	Standard (Average time less than)
Arrival to consultation (ATC)	Time taken by patient from arrival at primary triage until patient sees a doctor	Time patient enters consultation room - time patient arrives at primary triage	90 min
Length of stay (LOS)	Time taken by patient from arrival at primary triage until patient exits ED (either discharged home/ admitted)	Time patient is discharged from ED - time patient arrives at primary triage	120 min
Bed waiting time (BWT)	Time from decision by ED doctor for admission/ referral to primary team until patient arrives at bed in medical ward	Time patient arrives at bed in ward - time ED doctor decides for admission	120 min
Discharge time (DT)	Time taken from decision to discharge by physician until patient leaves the bed	Time patient leaves bed in ward - time patient is discharged home by physician	240 min

All the four outcome measures and benchmarks were selected based on the reviews of several studies with similar challenges on waiting times and process improvements at hospitals (11-16).

Statistical analysis

The results from the 36 hospitals were tested for normality using histograms and the Kolmogorov-Smirnov tests. The Wilcoxon signed ranks test were subsequently used to measure differences between pre- vs post six months-implementation, pre vs post one-year implementation; and post six vs post one-year implementation. Confidence interval was set at 95% and a p-value of <0.05 was considered statistically significant. Analysis was performed using the IBM SPSS Statistics version 22.

Results

The post-Lean implementation performance was measured twice at six months and one-year post implementation. The average times derived for each outcome variable were calculated: the average times for major specialists' hospitals (Table 3) and for minor specialists' hospitals (Table 4).

Table 3: Performance of major specialist hospitals

Outcome variables	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19	H20	H21	H22	H23	H24
Arrival to consultation (ATC)																								
Pre-lean	51	53	32	26	30	180	135	75	33	23	27	20	82	26	89	41	37	51	26	52	40	31	71	34
Post six months	42	51	46	25	34	85	85	62	28	21	26	10	82	54	116	38	27	44	29	50	48	25	66	39
Post 1 year	57	54	48	28	31	80	74	52	31	27	20	8	70	30	8	56	31	49	27	55	49	23	116	39
Length of stay (LOS)																								
Pre-lean	111	84	80	64	89	270	156	120	78	231	101	61	103	66	210	99	79	137	238	117	70	77	134	114
Post six months	100	95	133	63	98	153	114	100	59	57	63	51	116	79	324	92	77	92	231	87	75	264	134	80
Post 1 year	58	90	137	74	67	152	108	99	58	88	58	55	118	78	159	105	87	84	156	94	76	62	190	82
Bed waiting time (BWT)																								
Pre-lean	163	103	35	81	44	466	206	170	326	115	216	83	93	99	480	99	79	612	691	109	80	34	96	250
Post 6 months	146	58	71	83	29	384	135	145	67	57	115	71	107	79	176	68	117	172	234	146	101	34	166	47
Post 1 year	96	66	24	66	25	474	120	153	67	80	134	111	82	68	N/A	57	152	20	943	151	N/A	40	222	34
Discharge time (DT)																								
Pre-lean	185	328	226	131	139	242	360	204	280	240	148	191	288	225	217	352	239	354	203	390	160	282	496	355
Post 6 months	163	163	237	81	88	107	43	153	168	116	97	92	199	144	150	159	225	335	168	208	106	263	308	268
Post 1 year	180	171	134	38	122	81	27	146	127	47	99	181	183	196	182	143	253	210	158	166	110	281	276	N/A

All values are in average time (minutes)
H: Hospital
N/A: Not available

Table 4: Performance of minor specialist hospitals

Outcome variables	H25	H26	H27	H28	H29	H30	H31	H32	H33	H34	H35	H36
Arrival to consultation (ATC)												
Pre-lean	62	34	28	16	39	54	67	35	41	24	62	41
Post six months	41	27	26	13	33	21	56	62	45	15	67	31
Post 1 year	43	42	41	20	37	11	54	47	43	37	34	41
Length of stay (LOS)												
Pre-lean	116	64	64	105	78	264	123	102	139	67	73	192
Post six months	110	60	92	54	71	73	110	129	59	30	82	58
Post 1 year	110	72	92	66	78	51	99	112	52	70	32	72
Bed waiting time (BWT)												
Pre-lean	178	37	71	36	32	608	75	118	60	65	129	52
Post six months	158	53	60	38	24	87	101	88	73	65	52	76
Post 1 year	155	79	98	25	33	77	98	131	56	N/A	74	67
Discharge time (DT)												
Pre-lean	307	249	119	125	273	366	347	278	455	172	175	450
Post six months	152	244	80	85	213	123	140	97	162	192	141	200
Post 1 year	198	203	87	85	199	116	171	110	268	172	133	95

All values are in average time (minutes)
H: Hospital
N/A: Not available

The performances of the hospitals were then assessed using a Pabon Lasso model which was developed in 1986. The model utilises hospital indices simultaneously for the purpose of interpreting and comparing hospital efficiency (17). The said technique was also adopted and used for evaluation of the EDs' and MWs' performance at the two post-implementation intervals. For evaluation of the EDs, the outcome variables used included average time for ATC and LOS whereas the outcome variables used for the MWs encompass DT and BWT. An example of the 2x2 matrix is illustrated in Figures 2 and 3.

Emergency departments

Using the modified Pabon Lasso model, a graph with four quadrants was created. The ATC was placed at the X-axis while LOS was placed at the Y-axis. Using the benchmark for ATC to be at 90 min and LOS at 120 min, two dotted lines were drawn, as shown in Figure 2. The hospitals' performance was then mapped onto the graph. Quadrant A depicts efficient work process consisting of hospitals who managed to achieve targets for both ATC (<90 min) and LOS (<120 min). Quadrant B depicts downstream issues that exist in the work processes. Downstream is the point after the doctor's consultation until the patient is discharged, which is inclusive of diagnostic studies, either radiography or laboratory tests performed during the time the patient was attended to in the ED. Quadrant C depicts upstream issues which is the time from when the patient arrives at triage until the patient enters the doctor's room for consultation. Quadrant D is when there is a long ATC but a shortened LOS, which is deemed unlikely, since LOS is inclusive of ATC time. Therefore, this occurrence (if any) may suggest that there may be some error in the data collection or data entry.

Medical wards

Similar concept and processes were used to evaluate MWs' performance. DT was placed on the X-axis while BWT on the Y-axis. Dotted lines were drawn at 240 min for DT and 120 min for BWT, marking them as benchmarks. Quadrant A depicts efficient work process, consisting of hospitals that managed to achieve the benchmark for DT (<240 min) and BWT (<120 min). The other quadrants reflect inefficient work process, as illustrated in Figure 3.

As mentioned in the aim of this study, differences were measured between the 1) pre- and post-lean six months implementation, 2) pre-and post-lean one-year implementation and 3) post-lean six months with post-lean one-year implementation. Table 5 highlights the findings which showed that for post-lean six months implementation, BWT and DT were significantly lower in major specialist hospitals, with Z=-2.40 and Z=-4.20, respectively ($p<0.05$). On the other hand, minor specialist

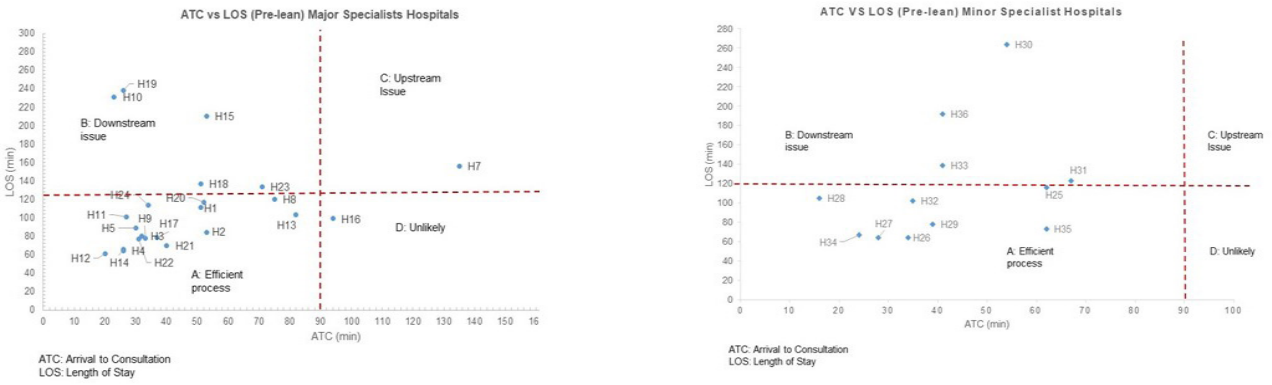

Figure 2: Emergency department's 2x2 matrix for the performances of major and minor specialists hospitals. The graphs show technical efficiency of hospitals using performance measures Arrival to Consultation (ATC) plotted against on Length of Stay (LOS). Quadrant A shows hospitals with efficient process, while B-C shows the hospitals having issue either downstream/upstream. Quadrant D deemed unlikely as it suggests inaccuracy in data reported

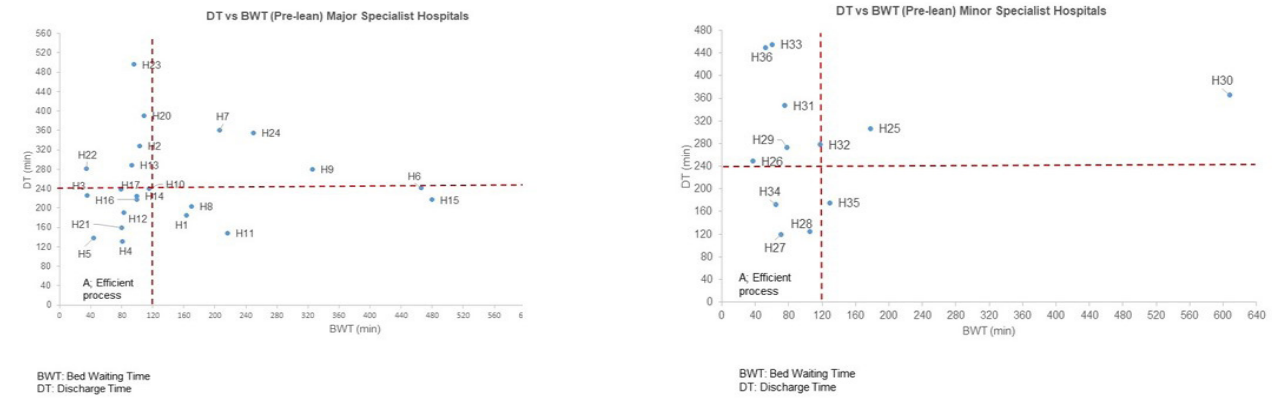

Figure 3: Medical ward's 2x2 matrix for the performances of major and minor specialists hospitals. The graphs show technical efficiency of hospitals using performance measures Discharge Time (DT) plotted against on Bed Waiting Time (BWT). Quadrant A shows hospitals with efficient process, while other quadrants reflect inefficient process

hospitals showed a significant difference in the DT with Z=-2.90, p<0.05. As for post-lean one-year implementation, LOS was significantly lower only for major specialist hospitals, with Z=-2.14, p=0.03, but not for minor specialist hospitals. DT was also found to be significantly lower in both major and minor specialist hospitals, with p<0.05 and Z=-4.08, and Z=-2.93, respectively. There was no significant difference in the post-lean six months and one-year implementation for all the outcome variables in both the major and minor specialist hospitals.

Discussion

Overcrowding and long waiting times is a situation affecting all nations globally (18-20). Nevertheless, the issue should not be taken lightly because it affects the efficiency of the country.

The success in reducing waiting time as evidenced from previous studies has inspired the commencement of Lean healthcare initiative in 2013 in MOH hospitals. Since then, the initiative has been scaled up to include all state hospitals in 2015, major specialist hospitals in 2016, and minor specialist hospitals in 2017. These hospitals share one common problem, which is the long waiting time, mostly in EDs and MWs. In order to manage the growing problem, hospitals that were exposed to Lean initiative and have been trained using Lean approaches congregated to brainstorm and to embark on their specific *kaizen* plans.

Nevertheless, most of the *kaizens* implemented by the hospitals, be it in major or minor specialist hospitals, were similar. Examples include setting up the discharge lounge to reduce bed-waiting time for patients in the ED waiting to be admitted to the MWs, creating the pre-discharge checklist for a smoother discharge process in MWs, redesigning hospital signages to improve patients' flow through each process in the ED and improving the registration system in the ED by using an integrated system (21, 22). It is important to note that although similar *kaizens* were implemented, these *kaizens* would probably impact each hospital differently, depending on the number of patients served, their execution process, degree of employee involvement and the management support rendered. At

Table 5: Non-parametric analysis of median difference using Wilcoxon Signed Rank test

Outcome variables	Major specialist hospital, p-value (Z)	Minor specialist hospital, p-value (Z)
Arrival to consultation (ATC)		
Pre-lean vs post 6 months implementation	0.23 (-1.20)	0.099 (-1.65)
Pre-lean vs post one-year implementation	0.56 (-0.59)	0.624 (-0.490)
Post six months vs post one-year implementation	0.96 (-0.05)	0.555 (-0.56)
Length of stay (LOS)		
Pre-lean vs post six months implementation	0.25 (-1.14)	0.084 (-1.73)
Pre-lean vs post one-year implementation	0.03 (-2.14)	0.091 (-1.69)
Post six months vs post one-year implementation	0.64 (-0.47)	0.838 (-0.20)
Bed waiting time (BWT)		
Pre-lean vs post six months implementation	0.02 (-2.40)	0.477 (-0.71)
Pre-lean vs post one-year implementation	0.10 (-1.62)	0.965 (-0.04)
Post six months vs post one-year implementation	0.77 (-0.29)	0.449 (-0.76)
Discharge time (DT)		
Pre-lean vs post six months implementation	0.00 (-4.26)	0.00 (-2.90)
Pre-lean vs post one-year implementation	0.00 (-4.08)	0.00 (-2.93)
Post six months vs post one-year implementation	0.34 (-0.96)	0.96 (-0.04)

the end of Lean initiative implementation, the hospitals' representatives presented their progress report to the stakeholders, discussing their progress, the barriers setting them back and the challenges faced (21, 22). Each hospital has its own unique characteristics in terms of the number of patients it served, the number of patient attendance to hospitals, specialties offered, and bed capacity, all of which depended on the hospital types. For that reason, our paper did not explore the hospitals' *kaizen* lists, but instead, chose to examine the variables that may influence or hinder the implementation process.

Based on our data analysis, it is clear that certain hospitals needed longer duration of time for the *kaizen* lists to be realised. This is supported by the LOS metrics, whereby the p-value for major specialist hospitals, between pre- and post-lean one-year implementation, indicated a significant improvement (<0.05) when compared to the p-value seen between pre- and post-lean six months implementation. It is clear that when data were collected after one year, the performance, in terms of LOS, improved which may be attributed to the longer duration of the post-lean implementation among the hospitals. This fact implies that if ample time and space were given to the hospitals to consider the Lean initiative, and for the hospitals to accept Lean implementation as a continuous process for improvement, it is likely that the people involved would be able to become motivated and work towards realising the suggested *kaizen* (23). It appears that after a longer period of exposure and implementation, hospital staff became familiar to Lean concept and *kaizen* improvements and began adapting it into their daily work. The Lean concept and *kaizen* render these hospitals to be more adept at executing their daily activities. In this regard, it was also observed that some hospitals may need more time to be fully adapted to Lean concept since there is no quick and easy way to implement Lean initiative (24). Some literature stated that when sufficient time for implementation is applied (25), it will create an even more successful implementation and a deeper appreciation of the Lean approach for all functions and processes of the hospital (25). ThedaCare, a community health system in Wisconsin, USA, required five years to achieve a significant improvement and to disseminate Lean concept across all departments in the hospital (26).

As seen from the findings presented, MWs tend to benefit more from Lean initiative as compared to the EDs. The implementation of Lean has shown a significant reduction in DT, both in major and minor specialist hospitals. Nevertheless, a significant time reduction for ED was only evident in major specialist hospitals with specific outcome measures showing significant improvements in the LOS and BWT. It is possible that there was no significant improvement in ED performance in minor hospitals because before Lean commencement, most of these hospitals had already achieved benchmarks set by MOH during the pre-Lean data collection (Table 4). The number of patients that minor specialist hospitals had to serve were fewer when compared to major hospitals and the cases were of lower complexity and specialty, making it less urgent for them to improve their waiting time. In contrast, major specialist hospitals had to deal with the pressure of enhancing hospital reputations via an improvement in service delivery and patient satisfaction. Both of these factors served as the major driver for Lean implementation in major specialist hospitals (27).

Table 6 displays the challenges faced by the hospitals which were grouped into six domains: i) staff's resistance to change, ii) infrastructure, iii) silo mentality, iv) financial restraint, v) inadequate human resources, and vi) Information technology (IT)-related issues, due either to instability or the lack of an adequate system.

Table 6: Challenges faced by hospitals during Lean implementation

Hospital	Staff' resistant to change	Infrastructure	Silo Mentality	Financial restraint	Inadequate Human Resources	IT System (inadequate/ unstable)
H1	x	x	x	x		x
H2			x	x	x	
H3	x		x		x	
H4	x	x	x		x	
H5		x		x	x	
H6		x				
H7		x				
H8		x				
H9						
H10						
H11					x	
H12		x	x	x		x
H13	x			x		x
H14	x					x
H15			x			x
H16	x		x	x		
H17	x			x		
H18	x	x				
H19	x					
H20	x					
H21			x	x		
H22	x	x		x		
H23	x					
H24						
H25		x			x	
H26				x	x	
H27					x	
H28	x	x			x	
H29		x		x		
H30					x	
H31		x		x	x	
H32			x	x	x	
H33			x			
H34	x	x				
H35		x				x
H36		x				

IT: Information Technology

Staff resistance/acceptance to change

Staff acceptance of Lean in their work processes is one of the crucial determinants for the successful implementation of *kaizen* (27). New staff who have no awareness whatsoever about Lean concept may find it difficult to cooperate with the new routines imposed by initiative. In contrast, senior or longer serving staff may be more resistant to learning or may have become overburdened by their current day-to-day tasks to consider the implementation positively. Thus, the idea of implementing new changes becomes a burden to them. Additionally, there may be poor understanding of Lean philosophy as it could be perceived as a passing fad (24). Moreover, when hospital staff do not fully understand the essence of Lean initiative, it is difficult for them to accept it. This mentality, called status quo, refers to staff's inclination to continue with their existing goals and plans, beyond the point at which a neutral observer, or a statistical model, would recommend a change in its course (28). It has been reported that employees have to be involved and get used to continued improvement process for the successful implementation of the Lean concept (26, 27)

Infrastructure

Most of the minor specialist hospitals were old hospitals and located in rural areas. As such, their designs and layouts, become unsuitable to cater to the current service demand. For example, one hospital had no elevator, but had only ramps connecting the wards to the other departments. The use of ramps hinders the movement of the portable X-ray machines from being pushed into the ED's vicinity and may cause them to be more susceptible to damage. Because of this, patients had to be transported to the radiology department for X-ray procedures. This, coupled with the lack of X-ray machines in the radiology department, contributed to the long queue for radiological investigations, contributing to the longer LOS in EDs. This incidence is just a single illustration of the many obstacles hindering the improvement efforts at the hospitals. Hospital renovation was also part of the suggested *kaizen* plan, but this plan was inadvertently halted due to the dilapidated condition of the hospitals which may lead to further damage in the structure.

In some of these hospitals, ED and the laboratories were located far apart, leading to further delay since hospital staff were required to manually deliver the samples to the laboratory and *vice versa*. The issue was highlighted in a study by Chan et al. (2014) (19), who observed that timely provision of porter services to deliver and collect samples from the laboratory played an important role in determining the length of stay for patients in the ED. The delays could be reduced with the use of pneumatic tubes which are absent in most minor specialist hospitals but are mostly found in the major specialist hospitals. Pneumatic tubes have managed to reduce motion waste among staffs who had to move back and forth to deliver and collect samples from the laboratory. Not only that, it also led to faster time for doctors to review the results and faster institution of treatment.

Silo mentality

Overall, ED services offered in Malaysian hospitals are cross-departmental. This means that besides the ED staff, services provided at the ED also involve staff from pathology and radiology departments. Thus, the situation in EDs is more complex than MWs because EDs need good inter-department cooperation to ensure the success of their *kaizen* implementations. One of the examples recommended for improving LOS was for the laboratory to give higher priority in processing samples from EDs, i.e., fast track samples from ED. Another recommendation was to create a special lane in the radiology department to specially cater for ED patients. However, often times, there is difficulty in convincing the laboratory and radiology departments to help the ED by also applying these *kaizen* implementations. Although these departments depend on each other to provide services to the patients, they seemed to be operating autonomously; also coined as 'functional silo' mentality where health care practitioners are separated and worked as individual professional groups (27). Functional silos lead to fragmented care and the *kaizen* planned may then be out of reach and unachievable (28). Every unit needs to collaborate and work together as one in order to make Lean implementation a success, as opposed to achieving only small incremental adjustments. The poor collaboration could be the reason why EDs did not fare as well as MWs. The culture of all units working together as one for the benefit of the hospital is still lacking. In order to eliminate this, it is necessary for the top management, ideally the heads of departments and hospital directors, to commit themselves to Lean implementation by being involved in the continual problem-solving efforts and plan transformational change across the whole organisation, not just in selected areas (23, 24, 27). Apart from good leadership, team commitment towards the organisation has also been recognised as a critical success factor in ensuring the success of the Lean initiative, its implementations, and its sustainability (27, 29, 30).

Financial restraint

A number of hospitals have pointed out that financial issue hampers successful Lean implementations. In general, the success of any project depends highly on its financial capability. Not only does the principle of the Lean initiative emphasize on delivering quality service, it also mentions the reduction in lead time, which consequently may lead to an overall reduced cost. The *kaizens* were implemented based on available budget. In some instances, additional funds may be needed to execute certain implementations successfully. It is such financial inadequacies which could consequently be the main limitation, hindering successful Lean implementation (26). Thus, hospital management has to officially endorse the initiative to ensure its success.

Inadequate human resource

It was also apparent that with the increasing backlog of work, the rate of conducting Lean initiative exceeded the organization's capacity to implement the solutions (31).

In this regard, it is necessary for the hospitals to consider which suitable *kaizen* should be implemented first. This requires proper planning and staff consideration. A study which examined outpatient clinics in South Africa showed that reduction of waiting time in clinics is not shown over a short period of time. It requires a longer period of Lean implementation before the targeted time can be achieved. It is plausible that the situation is contributed by the critical shortage of skilled labour followed by the fluctuating number of staff available (32).

Information Technology (IT) system

A study by LaGanga (2012) (31) referred to the availability of electronic systems and data accessibility as having an impact in measurability and time, in the implementation of solutions. The presence of electronic system facilitates the Lean initiative program with respect to the measurement of process indicators, the clinical activities progress, and the length of services. A systematic review made by Rasmussen (2012) (33) described how the electronic system helped a general internal medicine department transform their discharge planning from being unstructured to being a structured process and increased transparency. The presence of an adequate and stable system can diminish interruptions and promote better, necessary communications. This improvement in communications among the clinicians had resulted in the improved quality of care within EDs (33). Nonetheless, some drawbacks of the IT system were also reported. Due to lack of the IT system's flexibility and support, the clinicians were of the opinion that real-time additions were more practical. In addition, time is less wasted when the customisation of patient records could easily be improvised when made manually instead of through the time-consuming electronic system (33). Therefore, it is important to find leverage on the existing electronic systems so as to maximise its use for the best approach to complement and facilitate work processes in hospitals.

Limitations

The findings of this study might be restricted to 36 hospitals located within peninsular Malaysia and East Malaysia. The findings were constrained by several limitations. First, data collection was only done at three points (baseline, post six months and post one-year), hence we were unable to demonstrate the seasonal variations which may show an increase in the number of patients during the festive seasons. Proper data collection and analysis are undeniably important for measuring the performance metrics. Nonetheless, it has to be borne in mind that it is not the only determinant for measuring hospitals' efficiency. One must take into account the strategies applied and the impact these implementations may have on patients and employees.

Second, our study is unable to definitively attribute the improvements to specific components of the intervention and was not able to eliminate some confounders that may have contributed to the improvements achieved. Furthermore, the way the *kaizen* plans worked among the hospitals would vary from one hospital to another, depending on the tools and methods used, the implementation process and the support provided. Also, this study did not measure the patients' satisfaction rate which might have enhanced the result for the effect with the *kaizen* implementations.

Conclusion

Our paper is the first to report on Lean initiative in 36 major and minor specialist MOH hospitals, its performances and challenges experienced by these hospitals.

Sustainability should be a major concern of hospitals, thus embracing the Lean initiative as a culture should be the main aim of the hospitals. For it to be successful and sustained, the employees need to be able to appreciate the value of Lean in their day-to-day and staff must also be able to translate the value into their daily activities. It is believed that once the employees are able to implement Lean in their own work and daily activities, they would become role models for others, especially to those who are new to the concept of Lean. Without doubt, the top management and its support as well as active involvement with such an implementation is a crucial factor for determining the direction that Lean takes. Before embarking on any improvements, top management should ensure that the development of the infrastructures is aligned with the improvements planned which will help guarantee the success of Lean initiative and the *kaizen* planned. Added to this will be the sharing of best practices as the focus of the management when implementing it.

Future research should consider investigating which *kaizen* or factors best contribute to the performance of the improvements. It would also be interesting for future research to explore the critical success factors for the successful and sustainable implementation of Lean as well as customers' satisfaction rate, in line with the implementation of the initiative.

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Competing interests

All authors declare that they have no conflict of interest with respect to the research, authorship, and/or publication of this article.

Ethics statement

This study was based on the Lean Healthcare Initiative Program proposed by the Ministry of Health (MOH) during the year 2016 and 2017. There was no ethical issues since the study only involved administrative data and

not intervention on patients' medical records or patient's treatment decision process.

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