

INVESTIGATION OF FACTORS AFFECTING LEAN INITIATIVES AND IMPACTS IN GOVERNMENT HOSPITALS OF KERALA

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Abstract - This project aims to investigate the lean management interventions in Government hospitals in the state of Kerala. The study aims to analyze the factors affecting lean initiatives and impacts and to evaluate the performance improvements under lean implementation. The research also tries to identify various lean tools/practices applied in government hospitals. Through literature review it was identified that a total of 8 factors: strong leadership support, identifying lean with the strategic agenda of the healthcare, understanding what value and customer groups exist in healthcare, undertaking the end-to-end process view to identify and eliminate waste, personnel training and involvement in lean principles and methods, measurement and reward systems aligned to lean objectives, matching demand and capacity levels to improve flow, and employee satisfaction are influencing the dependent variable lean initiatives and impacts in the hospital. The research methodology was based on a questionnaire survey. Responses were collected directly from doctors, nurses, nursing assistants, auxiliary staff, and office staff across PHCs and CHCs in the Thrissur district. The study employed multiple regression analysis and independent sample T-Test to identify the significant factors among the 8 factors that are affecting lean initiatives and impacts in hospitals found through a review of the literature. The study suggests possible areas that need to be prioritized to accelerate quality initiatives using the lean principle in government hospitals. The study also helped to understand that lean adoption has brought positive impacts to government hospitals.

Key Words: Lean principle, Government hospitals, Questionnaire survey, Strong leadership, staff satisfaction.

1. INTRODUCTION

Due to the ever-increasing number of patients, shortage of staff, absence of planning in day-to-day activities, the healthcare sector is one sector that is always in need of restructuring in its way of operations. Healthcare providers have implemented various methods to improve the quality of care provided to patients. One such method used by healthcare authorities is the lean tools and techniques. Lean principle originated from the Toyota production system, is a set of techniques and activities used for the smooth running of a manufacturing or service operation. The techniques and activities differ according to the application but they have the same basic principle which is the elimination of all non-

value-adding activities and waste from the workplace. Lean principles are being introduced in the hospitals as a quality improvement program, which finds its application in reducing the waiting time to receiving treatment, record keeping, minimizing inventory, reducing transportation, preventing medical errors, and maximum utilization of human/machinery resources.

In a densely populated and developing country like India, the public healthcare sector holds a huge role in delivering healthcare services that are affordable to common people. In India, the healthcare sector is managed at the state level. Notably, Kerala, a southwestern state has consistently been a prominent outlier with better health outcomes in several areas compared to most states in India. Kerala's public health system comprises 18 general hospitals, 18 district hospitals, 86 taluk hospitals, 224 community healthcare centers, and 852 primary healthcare centers or family healthcare centers. One of the reasons for Kerala's achievement in healthcare is the strong emphasis from the government on continuously improving the public and the primary healthcare system. One recent effort to improve the quality of care in public healthcare is by undergoing a certification program named National quality assurance standards (NQAS). It was launched to introduce global best practices in healthcare to the public healthcare system thereby improving the quality of care provided to the patients. Currently, this certification program is carried out in various primary healthcare Centers (PHC) and community healthcare Centers (CHC) in the state. Most of the techniques used under these certification programs were found to be a part of the lean principle. Despite this many of the health centers have not gone for the quality initiatives. This project investigates the factors affecting lean initiatives and their impacts in Government hospitals of Kerala state, and to evaluate the performance improvements under lean adoption. The research also tries to identify various lean tools/practices applied in government hospitals.

2. LITERATURE REVIEW

The review was carried out for mainly 3 reasons they are, to identify various lean tools used in hospitals all around the globe, confirm the impact of lean in the healthcare sector, identify various factors influencing the lean initiatives in healthcare. Since the origin of the lean principle is from a manufacturing industry its application in service sectors like healthcare is debatable however Womack and Jones [1] have

advocated for the application of lean in healthcare. They argued that the first step in implementing Lean thinking in medical care is to put the patient at the forefront and include time and comfort as key performance measures of the system. Drotz, Poksinska [2], discuss the deeper understanding of the new roles, responsibilities, and job characteristics of employees in Lean healthcare organizations. The researchers studied various lean practices and their impacts in the 3 healthcare institutions like continuous improvement, 5S, flow orientation, self-managed teams, visual control, standardized work, coaching, and supporting leadership style. The study revealed that the lean implementation has created a new job culture among the staff which is more involved and increased cooperation in the hospital's quality improvement initiatives. Dickson et.al [3], Investigated the impact of lean in eliminating waste (fight crowding) and adding value (improve care quality) in the emergency department of 4 different Hospitals. The work included Process mapping of the current state, value analysis, and redesign based on the suggestion from front-line staff. The study concluded by reducing the length of stay in 3 of the 4 case hospitals despite an increase in patient volume. A factor that considerably affected the outcomes in the second- and third-year post-implementation was the level of continuous leadership commitment to Lean. Dogana, Unutulmaz [4], evaluate the pre lean and post lean conditions of a hospital by using a simulation-based value stream mapping (VSM). A simulation-based VSM method was added to the physical therapy and rehabilitation department of a public hospital. The proposed model revealed a reduction in patients' length of stay and non-value-added time. The future state mapping of the hospital showed more stability than the current state. Khurma, Pasek [5] has given the evidence application of various lean tools such as Cause & Effect Matrix, Fishbone Diagram, Cycle Time Analysis, Work Combination Charts, and Affinity Diagram. The study provided a Future State Layout that will dramatically reduce the amount of travel the patient and employees have to go through. Narayanamurthy et.al [6], confirm the applicability of the lean principle in the Indian healthcare sector. And categorized various performance measures such as Average waiting time at different nodes, Average total lead time from entering and leaving the hospital, Average redundant patient walking distance, Average percentage of cases rescheduled per day. The study also a framework for lean integration in healthcare institutions. Simon, Canacari [7], shown the evidence of usage of value stream process mapping, cause and effect diagram, and affinity diagram in healthcare. The researchers also state that by following the lean principle the hospital was able to utilize its rich reservoir of experience and talent for countering their most difficult challenges. Shogo Kanamori et.al [8], have revealed how the 5S management principle can bring positive outcomes in the healthcare sector of resource-poor countries like Senegal. 5S implementation showed positive results such as lesser unwanted items, improved orderliness, and improved labelling and directional indicators of service units. Al-

Balushi et.al [9], identified readiness factors that influence the lean initiatives in healthcare facilities based on an exploratory literature review. They are strong leadership team's support for lean, identifying lean with the strategic agenda of the healthcare setting, understanding what value and customer groups exist in healthcare, undertaking the end-to-end process view to identify and eliminate waste, personnel training and involvement in lean principles and methods, measurement and reward systems aligned to lean objectives, and matching demand and capacity levels to improve flow. Veth, Aij [10], identified various leadership characteristics that are required for the successful implementation lean principle. The study revealed basic lean leadership principles and identified specific leadership behaviours, skills, characteristics, and attitudes for each principle concerning the healthcare sector. A new leadership framework is suggested for Lean leadership requirements during Lean implementation.

The review revealed that the lean principle can bring a positive impact to the health system operations. Various lean tools have been successfully implemented in hospitals. Most of the reported studies are limited to the impact of lean on workforce and lack overall view. very limited studies were found in comparing the healthcare performance measures among adopters and non-adopters of the lean principle.

3. METHODOLOGY

From literature review 8 independent variables: strong leadership team's support for lean, identifying lean with the strategic agenda of the healthcare setting, understanding what value and customer groups exist in healthcare, undertaking the end-to-end process view to identify and eliminate waste, personnel training, and involvement in lean principles and methods, measurement and reward systems aligned to lean objectives, and matching demand and capacity levels to improve flow, and staff satisfaction were found to be influencing lean initiatives and impacts in hospitals. The present study used a survey of questionnaires to collect data from 12 hospitals in the state of Kerala, India. The respondents to the questionnaire included doctors, nurses, nursing assistants, office staff, auxiliary staff. A total of 128 respondents got among the adopters and non-adopters of lean. The questionnaire was developed in a 5 pointer Likert scale format. 56 variables were included in the questionnaire to study the influence of 8 independent factors on the lean initiatives and impact factor. 7 variables were included in the questionnaire to measure the performance difference among lean adopters and non-adopters. they are, Average waiting time in minutes to consult a doctor in the outpatient department, Average door to drug time, Bed occupancy rate, the hospital's acquired infection rate, Average staff satisfaction, Average patient satisfaction, average turnaround time of patient 1 variable was included in the questionnaire to identify lean tools used by the adopters. After data collection, IBM SPSS software was used for the data analysis purpose. A reliability test was used to check

how closely related the number of items is as a group. Confirmatory factor analysis was used to verify the factor structure of the questionnaire. Multiple regression analysis (MRA) was done on the collected data to identify the significant factors affecting lean initiatives and impacts in government hospitals. The significant factors identified from MRA were then compared between adopters and non-adopters of lean using an independent sample T-test to check whether there is any significant difference among them. The independent sample T-test was also used to compare the performance measures among adopters and non-adopters of lean.

4. DATA ANALYSIS

4.1 Reliability test

In this study, Cronbach’s alpha is considered for checking the reliability of the collected data. The Cronbach’s alpha ranges from 0 to 1. When the value of Cronbach’s alpha is greater than 0.7, then the item scales are regarded as reliable. Table 1 shows the summary of reliability. The Cronbach’s alpha score for all the factors is within the 0.821 – 0.960 range which indicates that the data is reliable.

Table -1: Reliability statistics

FACTORS	CRONBACH’S ALPHA
Strong leadership support	.948
Identifying lean with the strategic agenda of the healthcare	.874
Understanding what value and customer groups exist in healthcare	.871
Undertaking the end-to-end process view to identify and eliminate waste	.960
Personnel training and involvement in lean principles and methods	.908
Measurement and reward systems aligned to lean objectives	.929
Matching demand and capacity levels to improve flow	.821
Employee satisfaction	.921

4.2 Factor analysis

The study has used confirmatory factor analysis to check the validity of the measure. Confirmatory factor analysis is used since the factors are already got from the literature review. Factor analysis can be performed when the results of KMO and Bartlett’s test of sphericity are significant. The results of KMO and Bartlett’s test of sphericity of the present study indicated the appropriateness of factor analysis. (Acceptable

value for KMO test is greater than 0.6 and for bartlett’s test is lesser than 0.05). After confirming the appropriateness of the research constructs, the principal component analysis can be done to check the validity. factor loading of each item more than 0.5 and above 0.6 are considered highly significant for the research construct. 55 items out of 56 sub-factors showed good factor loading of above 0.5 and the 1 factor which is lesser than 0.5 was removed from further analysis.

4.3 Multiple regression analysis

Multiple regression analysis (MRA) was done to identify the most significant factors influencing lean initiatives and impacts in the government hospitals of Kerala. MRA checks the relationship of a dependent variable with two or more independent variables. In this study, 8 independent variables are tested against the dependent variable lean initiatives and impacts. Multiple linear regression analysis makes numerous key assumptions:

1. Linearity: there must be a linear relationship between the dependent variable and the predictor variable. Scatterplots can show if there is a linear or curvilinear relationship.
2. Normality: MRA assumes that the residuals are normally distributed.
3. No Multicollinearity: MRA assumes that the independent variables are not highly correlated with each other. Multi-collinearity assumption is tested by variance inflation factor (VIF) values. The VIF values of all factors were in between the acceptable range 1-10.
4. Homoscedasticity: this assumption states that the variance of error terms are similar across the value of the independent variables.

All the above conditions were satisfied and the multiple regression analysis can be performed. Below table 2 shows the significance value for the independent variables.

Table -2: Multiple regression analysis summaries

FACTORS	SIGNIFICANCE VALUE
Strong leadership support	0.589
Identifying lean with the strategic agenda of the healthcare	0.005
Understanding what value and customer groups exist in healthcare	0.085

Undertaking the end-to-end process view to identify and eliminate waste	0.868
Personnel training and involvement in lean principles and methods	0.229
Measurement and reward systems aligned to lean objectives	0.003
Matching demand and capacity levels to improve the flow	0.013
Employee satisfaction	0.947

As stated by (Cohen, 1988), the R2 value between 1.0 and 5.9 percent is considered as small, between 5.9 and 13.8 percent is medium, and higher than 13.8 percent is large. In this study, the coefficient of determination is 0.708, which implies that 70.8 percentage of the dependent variable can be described by the 8 independent variables.

Out of these eight factors it can be observed that only 3 factors namely, identifying lean with the strategic agenda of healthcare, measurement and reward system, and matching demand and capacity levels to improve the flow have a significant value of (P) less than 0.05 which concludes that these factors significantly influence lean initiatives and impacts in the healthcare facility.

4.4 Independent sample T-test

independent sample T-test is used to compare the means of a variable among two unrelated groups. Independent sample t-test is mainly used for the hypothesis testing purpose. In this study independent T-test is used for 2 purposes they are,

1. To check whether the significant factors from MRA differ among the adopters and non-adopters of lean.
2. To evaluate the performance measures among lean adopters and non-adopters.

The first test checks whether the factors, identification of lean with strategic agenda of healthcare, measurement reward system, matching demand and capacity levels to improve the flow differs among adopters and non-adopters. The test summary is given in table 3. Levene’s test examines the equality of variance in SPSS and if the t-test gives a significance value lesser than 0.05 then there is a significant difference among the unrelated groups. The result implies that the 3 factors significantly differ between adopters and non-adopters of lean.

Table-3: independent sample T-test 1

		Levene's Test for Equality of Variance	t-test for Equality of Means
		Sig.	Sig. (2-tailed)
Identifying lean with strategic agenda of healthcare	Equal variances assumed	.001	.000
	Equal variances not assumed		.000
Measurement and reward systems aligned to lean objectives	Equal variances assumed	.002	.000
	Equal variances not assumed		.000
Matching demand and capacity levels to improve the flow	Equal variances assumed	.650	.000
	Equal variances not assumed		.000

The 2nd test is performed to check whether the performance of hospitals has improved under lean adoption. To check this, 7 performance measures are compared among the adopters and non-adopters of lean. Table 4 shows the 7 performance measures compared and the summary of the independent sample T-test. The test showed that all the 7 performance measure statistics are better in lean hospitals as compared to the non-adopters of lean. This gives evidence for lean adoption is good for improving the hospital's quality of care.

Table-4: independent sample T-test 2

		Levene's Test for Equality of Variance s	t-test for Equality of Means
		Sig.	Sig. (2-tailed)
Average waiting time in minutes to consult a doctor in OPD	Equal variances assumed	.000	.000
	Equal variances not assumed		.000
Average door to drug time	Equal variances assumed	.000	.000
	Equal variances not assumed		.000

Bed occupancy rate	Equal variances assumed	.000	.000
	Equal variances not assumed		.000
Hospital's acquired infection rate	Equal variances assumed	.051	.000
	Equal variances not assumed		.000
Average staff satisfaction	Equal variances assumed	.000	.000
	Equal variances not assumed		.000
Average patient satisfaction	Equal variances assumed	.000	.000
	Equal variances not assumed		.000
average turnaround time of patient	Equal variances assumed	.000	.000
	Equal variances not assumed		.000

5. CONCLUSIONS

From the data analysis, it was found that tools such as 5S, fishbone diagram, PICK chart, process mapping, were used by all the lean adopting hospitals. Some hospitals were also observed to be using affinity diagrams, mistake proofing, visual management, PDSA, standardized work. lean adoption in the hospitals has brought positive results to the hospitals in terms of professional, patient, health system improvements. The study revealed that the factors, identification of lean with strategic agenda of healthcare, measurement and reward system, and matching demand and capacity levels to improve the flow have significantly influenced the lean initiatives and impacts in hospitals and these factors differ among adopters and non-adopters of lean. The study revealed that adopting lean has brought a positive impact on improving the performance of government hospitals in Kerala. By analyzing the sub-factors of the 3 significant factors, the research suggests future adopters of lean focus on certain areas before their quality improvement initiatives using the lean principle. they are,

- The hospital authorities should convey the need for lean and its long-term benefits to their employees before any effort towards quality improvement initiatives
- A reward system can be introduced which will create healthy competition among staff members.
- A cross-functional team consisting of staff from various departments can be formed to evaluate the lean initiatives in each department, do a gap analysis, and prioritize solutions.
- Efficient scheduling of the workforce during peak periods, inventory planning on essential tablets to prevent stock-outs, integrating best practices to the

work through standardization can improve the flow in healthcare and match the demand of the patients.

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