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RESEARCH PAPER

Lean Readiness Index for Malaysian Hospitals: An Exploratory Study

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ABSTRACT

This paper presents an exploratory study on the development of a lean readiness index for Malaysian hospitals. A questionnaire survey was obtained from 118 public hospitals, a lean readiness model is developed using structural equation modeling (SEM), and the relevant constructs are identified using confirmatory factor analysis. The Lean Readiness Index (LRI) is formulated and a LRI's ruler is proposed to meet the objective of the study. The finding to emerge from this study is that only 10.1% of Malaysian public hospitals have 'good' readiness status. The study also revealed the overall LRI's value is 0.617 and, the majority of the hospitals were categorized as having 'fair' and 'weak' readiness status. The result indicated that training had the strongest association towards lean readiness while communication is the least. This study revealed the readiness level for lean implementation in Malaysian public hospitals and proposed the required foundation that needs to be enhanced before implementing lean.

KEYWORDS: *Lean healthcare; Readiness index; Lean hospital*

1. Introduction

Over the past 20 years, lean has gained significant exposure with many organizations around the globe adopting it and still being one of the most promoted and competitive improvement models in use [31]. Despite being widely used in many organizations, the low rate of success in lean implementation had drawn concerned, especially among service organizations. Although there are many factors that contributed to the low success rate, the failure of an organization to be fully prepared and ready for lean could also be attributed. As such, the focus to assess lean readiness is essential as to provide guidance to organization leader in establishing a positive environment to enable lean to be adopted successfully.

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1.1. Assessing lean readiness

[17] summarized lean readiness as having the right conditions and resources in place to support lean implementation; having a clear vision and objectives for the intended change; and having the behaviors and motivation to engage with the change. Thus, prior adopting lean, an organization should perform the lean readiness self-assessment exercise [2] before making a commitment towards lean transformation. In brief, the purpose of a lean readiness assessment is to analyze the preparedness of the conditions, behaviors and resources need for the lean system to happen successfully.

1.2. The case study: malaysian hospitals

The drive towards patient-centered care demands more resources from the Malaysian Ministry of Health (MOH). In the current economic climate, MOH finds it challenging to meet all demands. Realizing also there is inefficiency and wastage in the delivery processes, MOH needs to find alternative's tool to sustain quality in the most effective and efficient manner. As part of the government's public service delivery transformation, lean healthcare was proposed [18]. Few lean pilot

projects were conducted focusing to reduce the congestion in medical wards and long waiting time at orthopedic, oncology and emergency departments. Following the success and its significance's impact, MOH had decided to expand lean healthcare initiatives to all its 133 public hospitals (Metro, 2014). This paper explores methodology used in determining the readiness of those hospitals towards lean implementation.

2. Literature Review

The implementation of lean methodologies within healthcare, often showing the benefits to patient care and resource utilization [6]. However, research also suggests the implementation is not without its problems, with the process depending on factors such as, culture of continuous improvement, effective leadership, the availability of resources and organizational readiness [23]. While most of these are critical success factors that need to be addressed during implementation stage, an organizational readiness is the pre-requisite that need to be accessed before decision was made to implement lean in an organizational [22].

2.1. Organizational readiness

Organizational readiness (OR) has been defined in terms of the social, technological, and systemic ability of an organization to try new things and change [5]. On the other hand, [27] considered OR as a set of dependent activities, which need to be addressed before an organization can begin to implement specific change management initiatives. Organizational readiness are 'enablers' and [9] call them as improvement focusing on an organization's awareness or realization of the need for improvement, planning the change and developing an organizational culture. Studies have shown that when organization did not undertake a process of creating readiness for change, the change effort either experienced false starts, the change efforts stalled as resistance increased, or the effort failed altogether [26],[30].

2.2. Lean readiness factors

Based on [21] and [1], the study compile a list of the Readiness Factor (RF) specific to health services. It is classified into seven categories, which includes 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. In addition, undertaking the end-to-end process view to identify and eliminate waste, personnel training in lean principles and methods, measurement and reward systems aligned to lean objectives, and matching demand and capacity levels to improve flow.

2.3. Relations of readiness factors to critical success factors

The study further explores if RF and Critical Success Factor (CSF) are common terms that can be used inter-changeably or should be treated differently when determining the effect on lean implementation in an organization. The idea of CSF first presented by D. Ronald Daniel in the 1960s. It then popularized by John F. Rockart, of MIT's Sloan School of Management, and since then CSF was used extensively to help organization implement their strategies and projects [8]. Rockart defined CSF as the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization.

Inevitably, the RF and CSF concept has evolved, and nowadays implemented in different ways and in some occasions were used to address on the same issue. For example, when discussing lean readiness level within Kuwaiti manufacturing industries, [2] uses CSF to refer to factors effecting lean implementation readiness. This study visualizes RF and CSF with reference to time based associate to the different stages of lean implementation in an organization as shown in Figure 1.

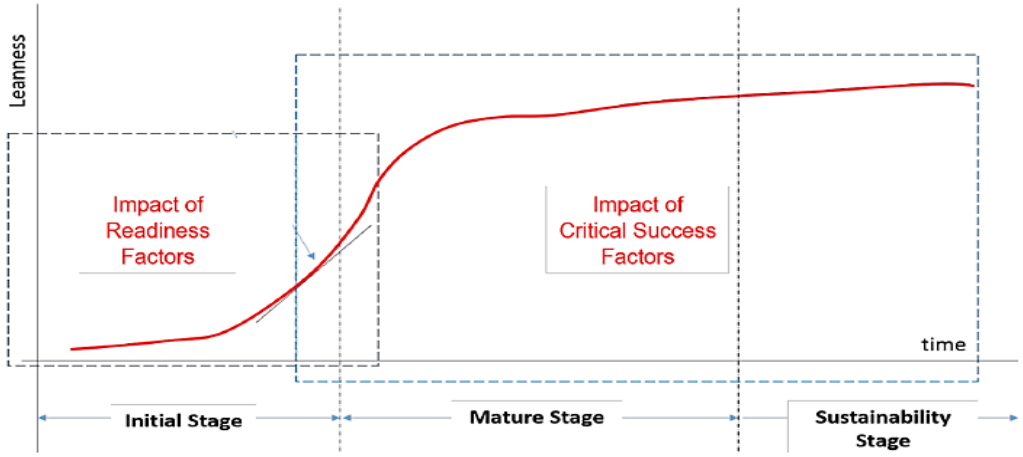

Fig. 1. Time based of readiness factor and critical succes factor in lean implementation

The RF referring to the factors to be addressed 'before' change implementation or before a project start. Its contribution mainly affects the initial start-up stage and the level of readiness determine the gradient of implementation. In contrast, CSF is to ensure successful performance that are referring to factors that affect the results and outcomes 'after' the implementation is matured. Nevertheless, for RF that also contributed to the successful performance especially after initial implementation stage, these are RFs that considered the subset of the CSFs.

2.4. Readiness assessment instruments

The preliminary aim of this study is to determine how to access lean readiness in a services organization such as the hospitals. In manufacturing, a similar study to access lean readiness level was conducted by [2]. The instrument based on comprehensive literature review, semi-structured interviews, and quantitative survey to small and medium-sized manufacturing industries. A measurement framework which encompasses constructs related to lean manufacturing (processes; planning and control; human resources; top management and leadership; customer relations; and supplier relations) is used to assess and determine whether they have the foundation to implement a lean system. This study also had reviewed instruments used to assess readiness on other subjects such as e-Health Readiness [25], e-Commerce Readiness [10], e-Government Readiness [3], Hospital Accreditation Readiness [20], College Readiness [28], and Technology Readiness [19].

3. Methodology

The study was conducted through four phases; literature review; structural model development; establish questionnaire; and readiness index development. The first phase establish the research gap by using systematic literature review (SLR) technique on subjects related to lean readiness, its critical success factors, hospital's organizational behavior and various readiness index instruments. The second part formulated research measurement models using structural equation modelling (SEM) and the research hypotheses while the third phase focused on questionnaire development and data collection. In the fourth phase, based on confirmatory factor analysis (CFA), the final lean readiness model was established and finally the lean readiness index (LRI) is developed.

3.1. Development of model

Formulating a theoretical model is an important start as it helps to assess and refine research goals, develop realistic and relevant research questions, select appropriate methods, and identify potential validity threats to the research concluded [14]. A theoretical model is a theory designed to explain an entire situation or behavior, with the idea that it would eventually be able to predict outcomes based on that behavior [12]. It attempt to explain a system or process basing it on a known theory or group of related theories.

In reference the above, study begins with establishing the relationship between organizational behaviors constructs to the readiness of lean implementation. The relationships are modeled into a preliminary theoretical model represented by a schematic diagram as shown in Figure 2. The schematic diagram presents the hypotheses of interest to be tested in the study. The constructs of interest involved are hospital's organizational behavior

and lean readiness factors. The relationship links hospital behavior as independent construct to lean readiness that serves as dependent construct. In this study, factors for lean readiness construct were adopted from lean manufacturing CSFs. Each construct having set of measurement items (Table 2 and Table 3) and data were collected using a questionnaire.

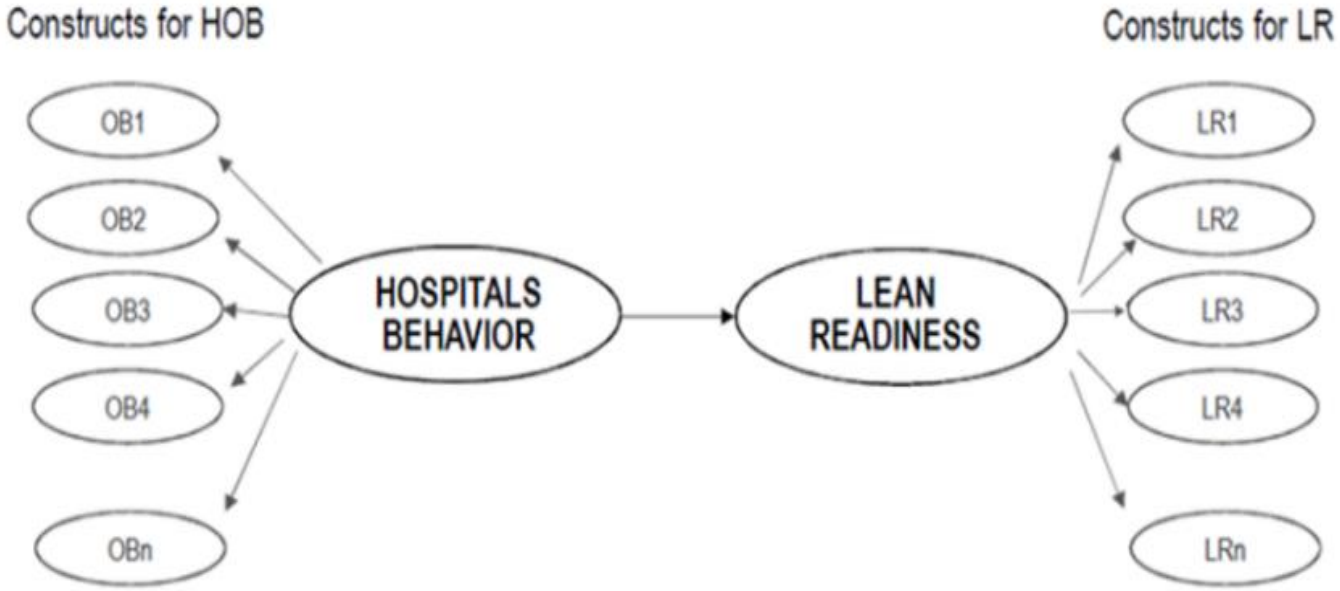

Fig. 2. Theoretical model of hospital lean readiness

Tab. 1. Measurement items for hospital behavior

Constuct	Measurement Item	
Leadership	BL1	Encourage new ideas
	BL2	Provide direction and support
	BL3	Strong leadership
	BL4	Handling conflicts
Commitment	BC1	Management participations
	BC2	Review improvement activities
	BC3	Willingness to try new ideas
	BC4	Willingness to take new task
Engagement	BE1	Openly talk new ideas
	BE2	Treat each other with respect
	BE3	Take accountability
	BE4	Training and advancement
Teamwork	BT1	Encourage each others
	BT2	Taking responsibility
	BT3	Real feeling of teamwork
	BT4	Real feeling of partnership
Communication	BO1	Communicate with other dept.
	BO2	Sharing of information
	BO3	Meeting are effective
	BO4	Good communication flow

Tab. 2. Measurement items for lean readiness

Constuct	Measurement Item	
Customer Alignment	LC1	Value for customers
	LC2	Focus customer issues
	LC3	Leadership behavior
	LC4	Results and performance
Enterprise Alignment	LE1	Strategy and methodology
	LE2	Policy deployment
	LE3	Lean awareness and understanding
	LE4	Management review
Process Alignment	LP1	Focus on continual improvement
	LP2	Identify and eliminate waste
	LP3	Use value stream approach
	LP4	Implement standardization
Culture Enablers	LU1	Respect every individual
	LU2	Good teamwork
	LU3	Passionate on improvement
	LU4	Staff are empowered
Trainig & Education	LT1	Training plan
	LT2	Link training to operation
	LT3	Support new ideas/ techniques
	LT4	Training effectiveness

3.2. SEM analysis approach

The approach to SEM analysis as suggested by Suhr (2006) starts with the review on relevant theory and research literature to support model specification. It then followed by developing a conceptual, preliminary framework or theoretical model. Next, to determine model identification such as parameter estimation, and then continue with selection of measures for the variables represented in the model. After this

stage, the data is to be collected and following it the researcher to conduct preliminary descriptive statistical analysis, which includes scaling, missing data, collinearity issues, and outlier detection. The next step is to estimate the parameters in the model and then perform model fit assessments and finally, to interpret and present the results.

3.3. Indexing method

LRI is an index to determine the level of hospital's preparedness towards lean implementation. It is a composite statistic of organizational behavior and lean readiness factors, used to rank hospitals based on their readiness levels. It worked on factors and items in-line with the lean readiness model using SEM. A hospital scores higher LRI when the organizational behavior shows higher level of readiness towards lean implementation.

The LRI combined two dimensions; hospital's organizational behavior which consist of 20 measurement items and lean readiness factors with 20 measurement items adopted from the shortlisted manufacturing lean critical success factors. The study used weighted sum of the R-squared to establish weighted factor that correlates between all the constructs. The constructs' weighted factors derived from its R-squared value extracted from the final structural model. R-squared is a statistical measure of how close the data are to the fitted regression line. It is also known as the coefficient of determination, or the coefficient of multiple determination for multiple regression and its value is between 0% and 100%. 0% indicates that the model explains none of the variability of the response data around its mean, while 100% indicates that the model explains all the variability of the response data around its mean. In general, the higher the R-squared, the better the model fits the data.

Next, developing the Construct Index (CI), an index representing lean readiness level for each contributing construct. The CI is the product of the overall mean score of measurement items belong to a particular construct against its weighted factor. The hospital lean readiness index is the summation of all its construct indexes as represented by below equation.

Lean Readiness Index: $LRI = CI_1 + CI_2 + CI_3 + ... + C_N$

-where C represent individual construct index and N is the total number of constructs

4. Results and Findings

Questionnaire were sent to all 133 MOH hospitals and every hospital supposed to be represented by two departments, which are the emergency department and medical department, thus resulted to a population size of 266. At the end of the survey period, 208 surveys which equivalent to 78.2% response rate were received. This accounted from 118 hospitals of which 90 hospitals represented by both departments and 28 hospitals by one department only. Data were analyzed using SPSS and then lean readiness model was developed using AMOS structural equation modeling.

4.1. The final structural model

The final structural model consists of 9 constructs and 31 measurement items is shown in Figure 3. The path analysis between HOB and LR shows it is significant (p-value < 0.001). Thus, the hypothesis that hospital organizational behavior has significant and positive effects on lean readiness is supported.

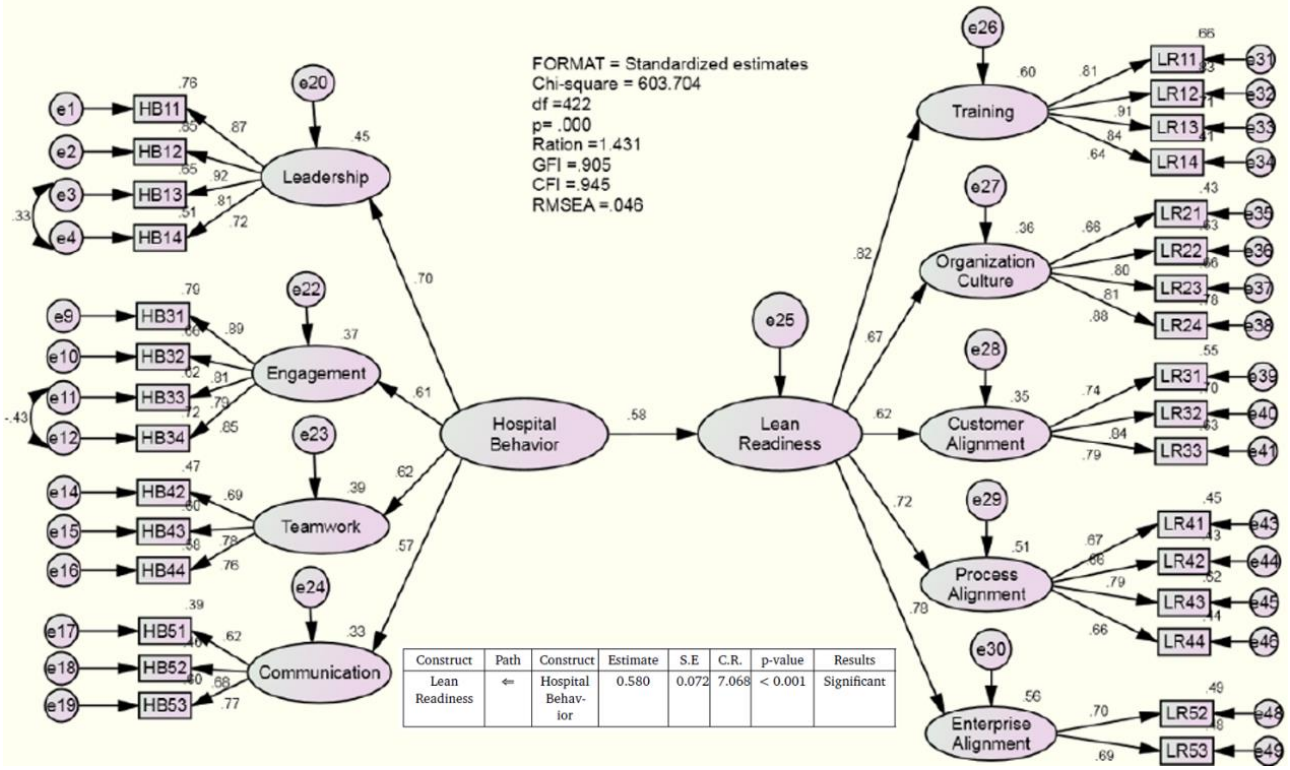

Fig. 3. The structural model linking hospital behavior to lean readiness

4.2. Construct weighted sum

Next, the study uses the weighted sum of the R-squared to establish weighted factor that correlates between all the constructs. In decision theory, the weighted sum model is the best known and simplest multi-criteria decision making method for evaluating a number of decision criteria [29]. The weighted factor for each construct was derived by dividing its R-squared value with the R-squared sum as the formula shown below and results summarized in Table 3.

Tab. 3. The Construct Weighted Factor

Construct		R^2	Weighted Factor	Mean
HOB	1. Leadership	0.45	0.115	0.098
	2. Engagement	0.37	0.094	
	3. Teamwork	0.39	0.099	
	4. Communication	0.33	0.084	
LR	5. Training	0.60	0.153	0.121
	6. Organization Culture	0.36	0.092	
	7. Customer Alignment	0.35	0.089	
	8. Process Alignment	0.51	0.130	
	9. Enterprise Alignment	0.56	0.143	
	Sum	**3.92**	**1.000**	

Having known the weighted factor for each of the construct next is to determine the Construct Index; an index representing lean readiness level for each contributing construct.

4.3. Construct index

The Construct Index (CI) is the product of the overall mean score of measurement items belong to a particular construct against its weighted factor. The summation of all contributing construct indexes formed the overall Lean Readiness Index (LRI) as formula shown below.

Lean Readiness Index: $LRI = CI_1 + CI_2 + CI_3 + ... + C_N$

(a) Construct Index: CIi = Wi x Fi

(b) Construct Factor:

$$F_i = \frac{(\sum_{n=i}^{n} S)/n}{5}$$

- Where CI is the construct index and N is number of constructs; W is the weighted factor, S is measurement item's mean value and n is number of measurement items.

Tab. 4. Derivation of lean readiness index for participating hospitals

Con -struct	Weighted Factor	Item	Item Mean	Construct Mean	Construct Mean %	Construct Index
C1	0.115	HB11	3.24	3.149	0.630	0.072
		HB12	3.11			
		HB13	3.05			
		HB14	3.19			
C2	0.094	HB31	3.15	2.945	0.589	0.056
		HB32	2.94			
		HB33	3.05			
		HB34	2.64			
C3	0.099	HB42	3.33	3.240	0.648	0.064
		HB43	3.19			
		HB44	3.20			
C4	0.084	HB51	2.82	2.980	0.596	0.050
		HB52	2.90			
		HB53	3.22			
C5	0.153	LR11	2.76	2.783	0.557	0.085
		LR12	2.85			
		LR13	2.78			
		LR14	2.74			
C6	0.092	LR21	3.20	2.783	0.557	0.085
		LR22	2.85			
		LR23	2.78			
		LR24	2.74			
C7	0.089	LR31	3.19	3.265	0.653	0.058
		LR32	3.40			
		LR33	3.20			
C8	0.130	LR41	3.12	3.223	0.645	0.084
		LR42	3.18			
		LR43	3.21			
		LR44	3.38			
C9	0.143	LR52	3.05	3.100	0.620	0.089
		LR53	3.15			
		Overall Lean Readiness Index				**0.617**

Table 3 shows results on the derivation of the construct indexes and the overall Lean Readiness Index for the participated hospitals. Analyzing on constructs' mean score, the questionnaire results revealed that C7-Customer Alignment had the highest mean score (3.265) while C5-Training is the lowest (2.783). Noted that these results are measured independently within the construct only and it reflects the individual construct level of readiness. Nevertheless, when analyzed on construct indexes, the highest now on C9-Enterprise Alignment (0.089) and the lowest is C4-Communication (0.050) as a result of weighted factor contribution which reflect its lower importance among the constructs. Finally, the summation of all the constructs indexes (0.617), represented the LRI for Malaysian public hospitals participated in this study.

4.4. Establishing index ruler

The LRI rates the lean readiness of hospitals relative to one another with maximum possible value is 'one' represents the highest level of lean implementation readiness and the minimum is 'zero' indicates the absolute lean un-readiness state. Nevertheless, the challenge was to establish the appropriate ruler and scale that can represent the LRI. For this study, it had adopted 'change readiness' ruler [4] as shown in Figure 4 as the preliminary reference ruler for LRI. The ruler used a scale of 1 to 5 and each component level of readiness assessed on a five-point Likert-type scale.

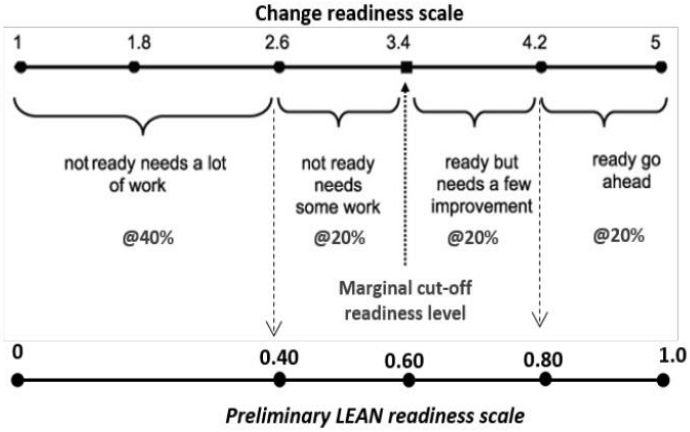

Fig. 5. Preliminary ruler for lean readiness index

Referenced to the change readiness ruler, the Lean readiness scales were divided into four quadrants. The first quadrant encompassed the first 40% of the scale which indicates that the hospital's status as "not ready" and still needs a lot of work before reaching the minimum implementation readiness level. The second quadrant covered the next 20% of the scale (0.40 to 0.60) which represent index with better preparedness level, but still falls within the "not ready" region and require some form of improvement work. Subsequently, allocation for the third quadrant is also 20%, with a scale of 0.60 to 0.80 which indicates marginal "ready status" and needs some minor improvement. The final quadrant covered the last 20% of the scale-represented index for hospitals with LRI above 0.80, which are considered as having a good readiness level for successful Lean implementation.

4.5. Validating index rules

The validation was done through analyzing the LRI for the 16 hospitals that had started implementing lean as of minimum period of one year. The mean LRI value for before and after lean started were used as reference to determine the LRI marginal cut-off value. Since this value represented status of 'after four to six months of implementation' while the study interest was to determine the actual value that represent when the readiness took placed, thus the study had used an estimation with the assumption that the increase in rate of readiness was moving linearly over implementation period as shown in Figure 6. A midpoint between implementation period was taken as the separation between ready and not ready, and this corresponded to the midpoint value of LRI between 'before and after lean implementation'. Thus, LRI of 0.642 was established as the marginal cut-off value for lean readiness which separated between 'ready and not ready' status.

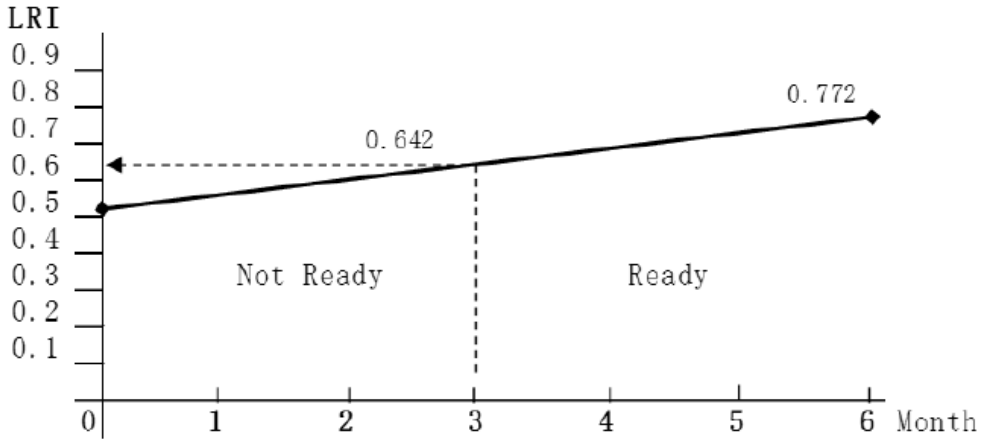

Fig. 6. Marginal cut-off LRI between readiness status

For the final ruler, the marginal LRI cut-off value was re-mapped to the ruler and proportionately by using percentage, and values were assigned to represent each readiness quadrant. Figure 7 shows the final validated ruler and based on the ruler the overall hospital readiness status is shown in Table 5.

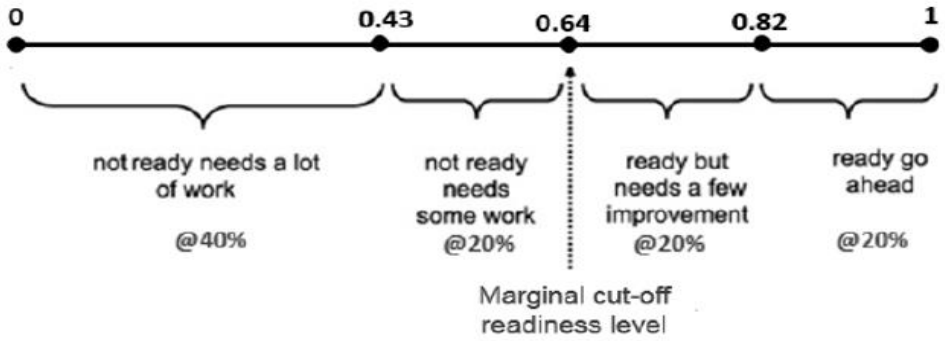

Fig. 7. Final ruler for lean readiness index

Tab. 5. Overall hospitals readiness status

Category	Readiness Level	Qty	%
1	Good - Ready to Implement	21	10.1
2	Fair - Need Few Improvements	103	49.52
3	Weak - Need Minor Imporvements	68	32.69
4	Poor - Need Major Improvements	16	7.69

4.6. Results summary

In this study, the researcher had determined the casual effect of hospital behavior on lean readiness. The results of SEM and correlation analysis supports the positive argument that the organizational behavior of Malaysian public hospitals has strong impact towards influencing the level of readiness towards lean implementation.

The final model consists of nine constructs with training being the strongest association follows by enterprise alignment, process alignment, leadership, teamwork, engagement, organization culture, customer alignment; and the least on communication. These results also proved that lean manufacturing critical success factors are significantly correlated and applicable in determining lean readiness in hospitals. Results from this research shows that only 10.1% of Malaysian public hospitals had 'good' readiness status. The research also found that based on the overall LRI's value of 0.617, the majority of the hospitals categorized as having 'fair' (49.5%) and 'weak' (32.7%) readiness status. Nevertheless, those 'fair' categorized hospital are already in 'ready mode' and should be able to transform themselves into 'good' readiness status with some minor improvement works. On the other hand, only a small percentage (7.7%) of the hospitals having poor readiness status that require major improvements before to start embarking lean.

4.7. Study findings

The findings from the study are as following:

I. Using structural equation modelling (SEM), the final lean readiness model was established which consist of nine constructs with a total of 31 measurement items. These items had directly influenced the level of lean readiness in Malaysian hospitals.

II. The results of SEM and correlation analysis implied that the relationship between hospital organization behavior (HOB) and lean readiness (LR) was high, thus indicates organizational behavior of Malaysian hospitals has a strong impact on influencing the level of readiness towards lean implementation.

III. The study shows only 10.1% of Malaysian hospitals had 'good' lean readiness status. It also found that based on the overall LRI's value of 0.617, the majority of the hospitals were categorized as having 'fair' (49.5%) and 'weak' (32.7%) readiness status.

IV. The result proved lean manufacturing CSF significantly correlated and is applicable in determining lean readiness for hospitals.

5. Conclusion

This study has developed a model to assess the impact of hospital organizational behavior towards lean readiness, also had assessed the applicability of manufacturing critical success factors in healthcare hospital setting. The results of this research revealed that generally the same factors are applicable to both manufacturing and healthcare in determining the level of readiness. The findings of this study have identified factors influenced lean readiness in Malaysian public hospitals. The implication of LRI enables authority to access lean readiness on each of its hospital, and taken appropriate actions to ensure successful lean implementation. Future works should further validate the index and explores the readiness effect on lean implementation sustainability.

6. Acknowledgement

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