ORIGINAL ARTICLE

Preliminary Framework of Lean Healthcare Sustainability Performance Measurement for Health Sector

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ABSTRACT

Introduction: Lean sustainability has gained prominence in the health sector for operational and business advantages. However, understanding the link between lean and healthcare sustainability, especially in social and environmental aspects, remains limited. This study introduces a preliminary framework for measuring lean healthcare sustainability in hospitals. The framework aligns Critical Success Factors (CSFs) with sustainability objectives and business strategies to ensure successful and enduring lean deployment. **Methods:** The study was conducted among 52 Lean Agile Hospitals in Malaysia using a cross-sectional approach. The validated questionnaire was employed for data collection. A reliability test and Exploratory Factor Analysis (EFA) were also performed to assess and validate the framework using Statistical Package for Social Sciences (SPSS) version 27. **Results:** The content validation was 0.9, which indicates that the instrument is sufficient to measure the research objective. The data screening test was performed to eliminate problem observation. The overall reliability value was over 0.830 which depicts data consistency and stability. The Kaiser-Meyer-Olkin exceeded 0.6, Bartlett's test was under 0.001 and factor loading was between 0.507 to 0.948, thus indicating a significant correlation matrix among at least some of the variables. Therefore, the latent factors were significant to specific items of the research. **Conclusion:** It is concluded that important CSF is aligned with the strategic level influence of lean deployment in healthcare, which has a specific impact on certain sustainability performance. Thus, this paper proposed a generic preliminary framework to measure lean healthcare sustainability.
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Keywords: Critical success factor, Sustainability, Organisational level, Lean healthcare

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INTRODUCTION

Lean sustainability continues to develop as service organisations encounter several challenges that limit their efficiency and effectiveness. The synchronization of lean thinking and organisational strategy has placed the organisation in the ultimate position to excel. The concept of lean has been widely applied in the service industry generally and adopted in healthcare specifically for approximately 15 years since 2005 to enhance the service delivery (1). The quality issue appeared affect performance forcing healthcare institution to adopt lean (2). The use of lean healthcare improves operation performance (3) and enhances care service to patients (4).

Despite the advantages of practice, most implementations often fail due to unidentified barriers. The CSF is a foundation in lean implementation (5), important key drive for changes (6) and basic measurements for sustainment (7). This holistic assessment evaluates lean implementation success and sustainability approaches. Nevertheless, most frameworks did not adopt the three fundamental pillars of sustainability (8). Previous researchers (9) studied about influence of CSF on the sustainability aspect but neglected to address the factors correlated to environmental and social impact. The sustainability and Triple Bottom Line (TBL) approach require integrated pillars which emphasizes preserving the environment and social life while maintaining economic desire (10).

The alignment of CSF and sustainability pillars is essential to synergise both principles. The CSF is an important in ensuring successful lean implementation (11) and a key to drive change (12) whereas sustainability refers to continuing to gain profit while avoiding negative environmental and social consequences (8). The economic pillar measures financial sustainability (13) and operation cost minimisation (14–16). While environmental pillar focuses on green practice initiative (13), preservation of resources (10) and waste reduction management (17). Social performance concerns employee health, safety and education (13), and employee commitment as well customer relationship (18,19). Table I summarises CSF linkage to sustainability. The specific CSF and objectives were linked that give impact to a particularly sustainable pillar.

Table I: CSF linkage to the sustainability aspect

CSF	Objective	Author	Linkage to sustainability
Leadership and management	To identify strategic planning to drive the organization towards excellence in business as well as establishing the clear direction of the organization for the operation enhancement.	(4,13–15)	Financial pillar
Organizational culture	The willingness of culture changes embedded innovation to enhance operational performance through adjusting current practice suit with lean objective.	(4,13–15)	Financial pillar
Employee involvement	The involvement of committed employees would result in good organizational performance.	(14,15)	Financial pillar
Lean practice and tool	The practice of correct lean technique in improvement implementation action.	(4,13,15)	Financial pillar
Quality measurement	To measure the progress of improvement implementation and lean progress to assess actual against targeted.	(4,13,15)	Financial pillar
Financial capability	Financial support and profit gained as a result of implementation.	(4,13,14)	Financial pillar
Customer satisfaction	To emphasize customer needs and satisfaction.	(4,14,15)	Social pillar
Employee satisfaction	To focus on fulfilling employee needs and target for future career.	(16)	Social pillar
Education and training	To prepare adequate knowledge and training before lean begin. Mistakes and defects can be avoided through proper training of the worker.	(4,10)	Social pillar
Efficient infrastructure	Accurate measurement and good tracking of progress can be achievable through an efficient infrastructure like supportive information technology and the availability of the tool.	(4,10)	Financial pillar
Environmental concern	To minimize waste generation and optimization of resources for efficiency purposes.	(17)	Environment pillar

The coordination of business strategy to organisation goal is required to support lean sustainability (20). The structured CSF linked to organisational level improved sustainment of lean deployment (21). The objective is to determine the specific measurement to be deployed at organisational level to achieve successful lean (22). Therefore, essential CSF measures should be deployed to different organisational levels (strategic, tactical and operational) based on targets to attain sustainable lean in organisation.

A strategic level approach should be embedded in lean deployment. The connection between corporate strategy with middle (tactical) and lower (operational) levels creates effective cooperation (5). A strategic level aligned with strategic factors such as leadership and management, financial aspect, customer focus and environmental concern responsible for overseeing the direction and vision for organisation excellence (5,11). While CSF aligns with tactical level focus on strategy goals suited to the execution planning (11). Furthermore, the operational focus correlates to lower management which execute according to department goal (5). Undefined responsibility of people's potential has contributed to the erosion of a system-wide lean implementation (23). Thus, aligning of strategic management and CSF crucial for lean success and sustainment.

The success of lean deployment is not determined based on the financial aspect but must be viewed from other angles to present the truly sustainability. A several models proposed by researchers to measure lean sustainability in an organisation but the assessment was not covered three pillars. The first sustainability model is illustrated in Figure 1 by previous researcher (24).

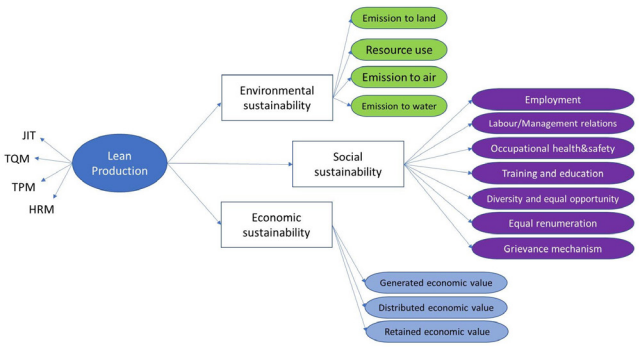

Figure 1: A conceptual model of lean sustainability. Adapted from Resta et al. 2016 (24) model

The study objective is to determine the impact of lean practice on sustainability at the organisational level through a case study approach (24). The lean sustainability conceptual model was proposed to assess organisational status. On the other hand, 31 sub-factors were embedded in the framework to develop sustainability performance measurement (25) as presented in Figure 2. However, both models lacked on lean and sustainability factor correlation due to unclear definition and pillar. Furthermore, an

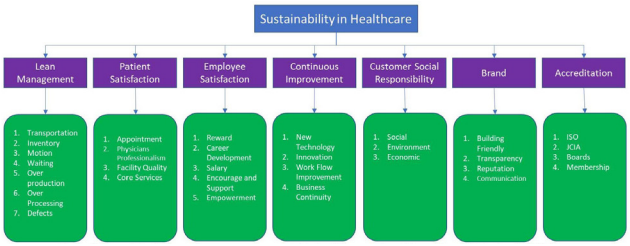

Figure 2: A sustainability performance measurement in healthcare sector. Adapted from AlJaberi et al. 2017 (25) assessment framework

undefined indicator measurement prevents achieving performance measurement objective. Less assessment of environmental and social pillar due to definition difficulty result to the poor sustainability evaluation (8).

Based on the review of previous studies, the preliminary of lean healthcare sustainability performance measurement framework for the hospital is proposed in this research. The framework comprises 56 factors, 11 perspectives and three levels of strategic management. 11 perspectives were aligned to the sustainability pillar before analysing phase to prepare a preliminary of lean healthcare sustainability performance.

MATERIALS AND METHODS

The target population is Lean Agile Hospital under the Ministry of Health Malaysia, (MOH). According to the National Institutes of Health Malaysia, (NIH) reported that 52 public hospitals involve in lean initiative. The programme was launched under MOH as part of the transformation programme in 2015 (26).

For this study purpose, the obligatory support from Malaysia Research Ethic Committee (MREC) was secured before obtaining list of Lean Agile Hospital from NIH. The respondents were selected based on criteria designed to avoid bias errors (27). The population sample was calculated using to Krejcie Morgan's table (28). A total of 204 questionnaires were distributed to respondents through Google form. Of the total, 150 respondents returned the structured questionnaire which reflected a 73.5% of response rate. This sample size sufficiently meets the requirement of factor analysis by Hair et al. (2010) (29).

The design of questionnaire was prepared and validated by an expert panel from academician and industrial sector. Six experts from the health institution and four academicians at university were identified based on criteria. The expert panel selection from both sectors were based on experience in the lean implementation field, skill and knowledge, educational background as well as organisation position (30). Face validity and content validity approach were used to ensure that item of each section was reliable and acceptable (27). A questionnaire was sent to experts to validate the instrument in terms of content, wording, sequence, respondent interest, time consumption, flow and continuity. The Item-level Content Validity Index (I-CVI) assessment was performed to quantify the expert judgement. The I-CVI assessment is a content validity test for experts to provide some indicator results (31). The threshold I-CVI value should be at least over 0.78 (32).

Data were analysed using SPSS version 27. The analysis begun with data screening which involves outlier and multicollinearity tests. The data screening was conducted to eradicate problematic data and minimise any statistical test issues (29). Outlier and multicollinearity tests were deployed to identify harmful data survey which required remedies to be performed. Subsequently reliability test was deployed to measure quality of the data collection. The threshold value for Cronbach's Alpha must be at least 0.6 to present the consistency of data measurement (29,33). The assessment focused on stability and consistency aspect of data (27). The next assessment was Exploratory Factor Analysis (EFA) that aimed to determine item measures and factors for the development of preliminary framework (34). The FA method as an inferential statistic was used to obtain initial conclusion of research.

RESULTS

The initial stage of research involved instrument validation by experts from hospitals and academic sector. The questionnaire was examined to enhance instrument quality. Hence, content validity using I-CVI approach was applied to quantify expert judgement into significant indicators.

The result of I-CVI value for each expert exceeded 0.78, thus indicating that the experts agreed items of instrument adequately measure based on the objective of the research. The questionnaire quality was improved and modified based on the face validity results.

The general analysis was conducted to understand respondents' background and knowledge of lean area. The first section of the survey presents respondents' positions in the organisation and quality management experience. The most respondents (45%) in this survey were at execution management level including doctors, officers and nurses involved in the lean project. While middle-level and top-level management represents 32% and 23% of respondents respectively. Over 65% of respondents have experience of at least five years in lean practices and project implementation in their area. The next survey determines the level of lean adoption and sustainability approach in hospital. Overall, 90% of respondents stated that organisations have begun implementing lean healthcare. However, lean adoption approach differs based on the department. Most respondents (60%) agreed that lean healthcare

must be implemented in critical department such as emergency and internal medicine. Meanwhile, others suggested implementing the approach at orthopaedic, pharmacy and ophthalmology areas due to increased demand. Furthermore, 93% of respondents believe that cost savings, operation efficiency increment, quality service enhancement and waiting time reduction can be achieved if lean is implemented and sustained. Thus, this indicate that sustainability of lean healthcare approach is a critical strategy to enhance operational performance.

The final section asked about the factors of lean success at the hospital. 56 CSFs identified from previous literature review analysis and were grouped into 11 perspectives which covered economic, environmental and social aspect. Then CSF linked to organisational strategy level. A five-point Likert scale was used from "very important (5)" to "not important at all (1)" for 56 factors assessment. The Likert point scale intended to enhance respondent convenience during the survey process and reduce respondent confusion (35). The respondents indicated the critical factors contribute to the successful and sustainable lean healthcare. Significantly, 99% of respondents considered it necessary to identify the right lean factor to ensure sustainable lean practice in organisational operation.

The data screening was applied to identify harmful data or items which affect statistical analysis. Results of last section (identification of 56 CSFs) were used for the screening analysis. The first screening test was outlier analysis using box plots figure. Data observation located outside of box plot whiskers was defined as outlier data (36). The results indicated that outlier data were recommended to be omitted.

While the second analysis was multicollinearity test using SPSS 27 software. The objective to determine two or more items which highly correlated (37). The assessment of multicollinearity problem was performed using a correlation analysis. The correlation value between 0.3 and 0.8 indicate that the item sufficiently correlates with each other and has no multicollinearity issue (29). Thus, item with a correlation value outside the range considered as collinearity issue exists. Based on the result, five perspectives (factor) had multicollinearity issues on items belonging to this perspective due to exceeded threshold limit. Nine items were recommended for delete due to highly correlated with other item in particular factors.

The Cronbach's Alpha was used to measure the consistency and stability of data collection from survey. The value of Cronbach's Alpha exceeding 0.6, suggests that all items are accepted and reliable to be used for further statistical analysis. Observably, items belonging to the factor demonstrate homogeneity and inter-correlation. Table II summarises item reliability.

Table II: Reliability test result

Perspective	Cronbach's Alpha	N of Items	Item deleted
Employee involvement	0.877	5	None
Organizational culture	0.863	5	None
Employee involvement	0.901	6	None
Lean practice and tool	0.902	4	None
Quality measurement	0.877	2	None
Financial capability	0.906	3	None
Efficient infrastructure	0.830	3	None
Customer satisfaction	0.902	7	None
Employee satisfaction	0.898	4	None
Education and training	0.865	4	None
Environmental concern	0.918	4	None

The EFA test was conducted to determine whether significant items to underlying factor (perspective) exist. The objective of EFA is to decide the initial structure of items and number of latent factors performed in the development phase which include knowledge of items of scale (38). According to Table III, sustainability pillar of financial and social was changed after EFA analysis implemented. While environmental pillar was remained and none of item was recommended to be deleted.

Financial pillar was extracted into four perspectives with the eigenvalues for all four perspectives were higher than one. Table III indicates that the cumulative variance for all perspective is 78.57% which contribute to significant of latent factor. Thus, four perspectives were significant to structure 23 item measures. Five items were deleted due to less than threshold of communalities (>0.5) and factor loading (>0.5).

The social pillar was extracted to two perspectives with the cumulative variance for is 78.62%. A total of 14 item measures were structured under two perspectives with one item deleted due to the communalities value below than 0.5. The environmental pillar was extracted to one perspective with none of item was deleted. All pillars had a Kaiser-Meyer-Olkin (KMO) value of over than 0.6 and Bartlett's test revealed a score under 0.001 which indicate correlation matrix has a significant correlation among at least some of the variables (39).

DISCUSSION

TheAs compared to previous study regarding importance of CSF to the sustainability of lean at healthcare organisation by Swarnakar et al. (2022) (6) demonstrated that employer and employee, continuous deployment of practice, financial and organizational structure support were the most prioritised factor in lean sustainability. Meanwhile education and skill enhancement, as well as social and environmental factor were second and third priorities in lean adoption. On the other hand, Souza et al. (2018) (40) proposed a model for sustainability improvement of the lean system which emphasized

Table III: Factor analysis result

Pillar	Before EFA	After EFA	KMO	Bartlett's test	Cumulative variance	Factor loading	Communalities	Deleted items
Financial	7 perspective and 28 item measures	4 perspective and 23 item measures	0.932	$p < 0.001$	78.57%	0.507 to 0.871	0.615 to 0.913	1 item deleted due to communalities < 0.5 4 items deleted due to factor loading < 0.5
Environmental	1 perspective and 4 item measures	1 perspective and 4 item measure	0.864	$p < 0.001$	86.92%	0.929 to 0.948	0.851 to 0.898	None
Social	3 perspectives and 15 item measures	2 perspectives and 14 item measures	0.940	$p < 0.001$	78.62%	0.525 to 0.867	0.715 to 0.857	1 item deleted due to communalities < 0.5

on economic, environmental, and social dimensions. Financial pillar factor that important for organisation primarily focuses on enhancing efficiency aspect while environmental impact reduction and employee skill improvement factors were included in the environmental and social pillar focus respectively. This finding of research is in line with lean manufacturing study regarding assessment of sustainability in three different aspects (24).

Previous studies outlined that organisation began to monitor the sustainability of lean system (24,41). The studies emphasized on lean sustainability at organisation system by assessing the ability in different aspects which include top management, staff, culture, education, social and environmental. Multi pillar evaluation provides a holistic view of the lean status in the organisation that able to determine which aspect has to be improved. Future research could be improved by following conclusion and recommendation by Tasdemir and Gazo. (2018) (8) to identify a complete and holistic factor to achieve a truly sustainable initiative.

Based on the analysis implemented to evaluate and assess data collection, the preliminary of lean healthcare sustainability measurement framework for hospital was proposed in this research. The assessment framework proposed is alignment with the future lines of research which aimed to assess the impact of lean on sustainability goal at the health sector (42). This study complement weakness in attaining a sustainable operation involving interest in the economic, environmental, and social impact for a better future. Thus, the following Figure 3 depicts the proposed model of lean sustainability aligned with the strategic management level to ensure that the approach is achievable and practical when adopted in the health sector.

Recommendation for Future Research

The following areas were identified as opportunities for future research:

a. To develop a generic lean sustainability performance that consists of three pillars generally and specifically emphasized in environmental aspect. This would be useful as a basic draft to evaluate the lean approach application in the healthcare area.

b. To further identify sub-factors of CSF that aligned to strategic, tactical and operational levels to optimise the potential of resources.

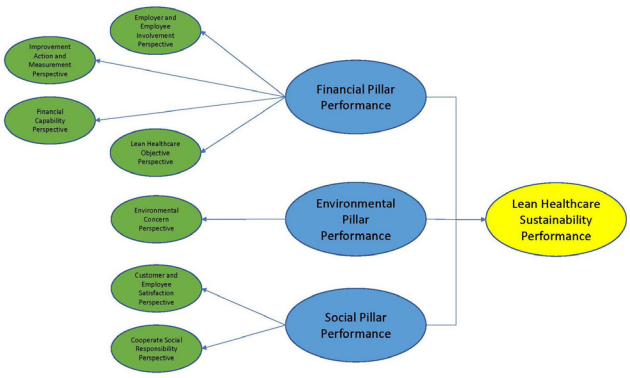

Figure 3: A Proposal of Preliminary Framework to Assess Lean Healthcare Sustainability Performance

CONCLUSION

This research proposed a performance measurement model to evaluate lean healthcare sustainability at the hospital. The reliability, validity and EFA assessment were conducted to identify specific CSFs which aligned to sustainability objective and organisation strategy approach. Lean sustainability can be verified if the practice aligned with three aspects of sustainability (economic, environmental and social) (8) with organization strategic level (5). Thus, this research developed a preliminary framework of lean healthcare sustainability model to fulfil this research objective.

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