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Analysis of the Level of Importance and Ease of Implementing Lean Construction in Building Construction Projects in Aceh Province, Indonesia

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A B S T R A C T

Lean construction is a construction implementation method that can minimize waste and maximize value. The problem is that there are still many contractor companies that adhere to conventional implementation methods. Lean construction has been introduced by the central government since 2016. This research aims to determine the level of importance and ease of implementation of lean construction on building construction projects in Aceh Province according to perceptions of the qualifications of small and non-small contractor companies partially and simultaneously. Draft Lean construction evaluated as many as 47 indicators. This research uses quantitative methods through questionnaires with a sample of 78 contractor company personnel. Technique sampling used proportionate stratified random sampling. Data analysis techniques used descriptive statistics and importance-performance analysis (IPA). The research results show that in the application of lean construction, according to the perception of small contractor companies, there are 11 indicators that are considered important and not easy to implement. The application of lean construction according to the perception of non-small contractor companies, there are 6 indicators that are considered important and not easy to implement. The application of lean construction according to the perception of small and non-small contractor companies, there are 11 indicators that are considered important and not easy to implement. For small and non-small qualifying contractor companies to increase readiness for implementation of lean construction in building construction projects in Aceh Province, it is necessary to increase the readiness of the indicators included in quadrant A.

1. Introduction

Lean construction is a construction implementation method that tries to minimize waste and maximize value. Waste is all forms of waste, while value is the value that should be achieved in the project. Thus, lean construction does not aim to streamline construction forms. However, lean construction aims to streamline all forms of waste or waste that have the potential to occur and focuses on increasing work productivity during the construction project implementation cycle. After the Central Government introduced the method of lean construction in 2016, implementation regulations have not been issued, as have regulations governing the implementation of sustainable construction. The implementation of sustainable construction is regulated in the Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia, Number 9 of 2021. This regulation states that the implementation of construction services for constructing buildings or civil structures must implement sustainable construction.[1-4]

There are no regulations regarding the implementation of lean construction; the implementation of building construction projects, especially in Aceh Province, is still a very profitable waste and neglected value. This is because there are still many contractor companies that adhere to conventional or traditional implementation methods. Conventional implementation methods tend to

produce waste and neglected value. As for form waste, which commonly arises in building construction projects, such as waiting time for instructions, waiting time for materials to arrive, waiting time for tools to arrive, loss of materials/equipment at the site, waste of materials and raw materials, damage to materials and ingredients at the site, idle labor, errors in work instructions, slow/ineffective workers, work rework/repair, and work accidents occur. Neglected form value in building construction projects, such as low quality of work and delays in project completion.[5-9] This study aims to analyze the importance and ease of implementation of lean construction on a building construction project in Aceh Province, Indonesia.

2. Methods

This research uses a quantitative method approach. Quantitative methods were used to examine respondents through questionnaire data collection. The object of this research is a building construction project. The criteria for building construction projects reviewed are those that have been completed by building subclassification contractor companies (BG001–BG009) with small and non-small qualifications, using funding sources from the 2017–2023 Aceh Revenue and Expenditure Budget (APBA), and have a contract value of > 1 billion rupiah. A total of 78 research objects were included in this study. The questionnaire instrument was designed based on 2: Part A questionnaire was designed to ask about the characteristics of the respondent. Part A of the questionnaire includes 6 indicators, namely gender, age, highest level of education, company position, company qualifications, and number of building construction projects ever built. Answers to part A of the questionnaire are measured according to the respondent's personality. Part B of the questionnaire was designed to ask about the level of importance and ease of implementation of lean construction on the project construction building in Aceh Province. As for implementation indicators, lean construction can be seen in Table 2. Each indicator is assessed for the level of importance (Y) and level of convenience (X). Answers to part B of the questionnaire are measured using a Likert scale of the 4-level model. Scale Likert for assessing the level of importance (Y) indicators are very unimportant (STP) with a score of 1, not important (TP) with a score of 2, Important (P) with a score of 3, and very important (SP) with a score of 4. Likert scale for assessing the level of ease (X) indicators are very not easy (STM) with a score of 1, not easy (TM) with a score of 2, easy (M) with a score of 3, and very easy (SM) with a score of 4.

Instrument testing is carried out through validity and reliability tests. In this case, if all indicators are valid and variable reliable, then the direct questionnaire design can be used as a research data collection tool. However, if there are invalid indicators, then the questionnaire design must be modified. Importance performance analysis (IPA) is used to evaluate the percentage of readiness compliance, readiness difference, and level of implementation readiness lean construction on building construction projects in Aceh Province based on the level of importance and convenience of small and non-small contractor companies partially and simultaneously.

3. Results and Discussion

Table 1 shows the indicators for the level of importance and ease of implementation of lean construction. All of them are valid because they have the value $R_{count} > R_{table.}$ This means that based on the perceptions of 30 contractor company personnel, 47 indicators are implemented lean construction is appropriate or appropriate to review for building construction projects in Aceh Province. Table 2 shows that the variables are the level of importance and ease of implementation. Lean construction has a value Cronbach Alpha > 0,6 so that variable is reliable. This means that based on the perceptions of 30 contractor company personnel, all indicators are of a level of importance, and ease of implementation of lean construction is representative of the variable.

Table 1. Validity test questionnaire.

No.	Lean construction implementation indicators	R_{count}		R_{table}	Information
		Level of importance	Convenience level		
1	Daily meetings with the workforce	0,480	0,795		Valid
2	Prefabricated	0,557	0,648		Valid
3	Continuous improvement	0,545	0,707		Valid
4	Team preparation	0,475	0,513		Valid
5	Eliminate waste	0,677	0,614		Valid
6	Standardization of work to increase time efficiency	0,483	0,592		Valid
7	Analysis 5 whys to find the root cause of the problem	0,515	0,728		Valid
8	Total quality management	0,736	0,642		Valid
9	Visual management	0,706	0,752		Valid
10	First attempt at process execution	0,600	0,576		Valid
11	Error checking	0,562	0,499		Valid
12	Value stream mapping	0,539	0,700	0,361	Valid
13	Fishbone diagram to find the root cause of the problem	0,634	0,532		Valid
14	First-in, first-out material	0,645	0,645		Valid
15	Analyze failure modes and impacts	0,578	0,749		Valid
16	Control the amount of material	0,633	0,765		Valid
17	The final planning system involves the involvement of many parties	0,568	0,517		Valid
18	Do a Pareto analysis to find out cause and effect	0,555	0,486		Valid
19	Implement the plan do check act cycle (plan, do, check, act)	0,524	0,707		Valid
20	On-time delivery	0,589	0,693		Valid
21	5S process (sorting, organizing, cleaning, habituating, and disciplining)	0,545	0,510		Valid
22	Management commitment	0,566	0,598		Valid
23	Provide training courses in lean *construction*	0,652	0,667		Valid
24	Employ employees who have knowledge of lean construction	0,677	0,736		Valid
25	Effective communication	0,385	0,688		Valid
26	Cross-functional teamwork (collaboration)	0,645	0,668		Valid
27	Documentation of the implementation process	0,624	0,605		Valid
28	Plan implementation	0,736	0,605		Valid
29	Comparative studies with leading top companies	0,576	0,682		Valid
30	Quality and reliability of material suppliers	0,506	0,601		Valid
31	Building relationships with suppliers	0,751	0,765		Valid
32	Building relationships with owner	0,714	0,618		Valid
33	Using a supportive contract form lean construction	0,545	0,697		Valid
34	Worksite layout design	0,562	0,642		Valid
35	Workforce balancing	0,696	0,688	0,361	Valid
36	Producing in small quantities	0,650	0,795		Valid
37	Reduction of supply chain processes	0,505	0,553		Valid
38	Reduction of working time	0,501	0,528		Valid
39	Work scheduling	0,666	0,691		Valid
40	Reduction of assembly processes	0,483	0,579		Valid
41	Reduction of operational cycle costs	0,566	0,476		Valid
42	Increased efficiency and preservation of materials used in projects	0,745	0,613		Valid
43	Project waste reduction	0,589	0,724		Valid
44	Improved occupational health and safety	0,408	0,604		Valid
45	Saving energy and water used in the project	0,403	0,645		Valid
46	The building design is integrated with building information modeling (BIM)	0,563	0,687		Valid
47	Conservation of resources and environment	0,656	0,629		Valid

Table 2. Reliability test questionnaire.

Variable	Cronbach Alpha > 0,6		Information
	Level of importance	Convenience level	
Application of lean construction	0,960	0,969	Reliable

Personnel from small qualified contractor companies in this study amounted to 57 respondents. Characteristics of 57 small qualified contractor company personnel: all of them are male, predominantly aged 31-40 years, last education at the undergraduate level, company position at level site engineer, and the number of building construction projects that have been built is 4–6 projects. Personnel from non-small qualifying contractor companies in this study amounted to 21 respondents. Characteristics of 21 non-small qualified contractor company personnel, all of whom are male, predominantly aged 41-50 years, highest education level S1, company position at level project manager and site engineer, and the number of building construction projects that have been built is 7–9 projects. Perceptions of small and non-small contractor company personnel's partial qualifications towards the level of importance and ease of implementation of lean construction have different evaluations. This is because a person's perception is influenced by subjective ways of thinking and feeling. These different perceptions can be accommodated through values mean, which is completed through descriptive statistics. Based on the perception of partially qualified small and non-small contractor company personnel, a modified IPA analysis can then be applied. The analysis of modified IPA in the context of this discussion aims to determine the percentage of suitability of readiness, the difference in readiness, and the level of readiness in implementing lean construction on building construction projects in Aceh Province according to the perception of small and non-small qualifying contractor companies partially. Readiness suitability (TKi) is a condition where partially small and non-small qualifying contractor companies perceive the level of ease as being the same as the level of importance of implementing the indicators of lean construction. The difference in readiness (gap) is a difference in the perception of small and non-small qualifying contractor companies partially between the level of ease and the level of importance of applying the indicators of lean construction.[10-14] The suitability of readiness and the difference in readiness for implementation of lean construction on building construction projects in Aceh Province, according to the perception of small and non-small contractor companies, the partial qualifications can be shown in Table 3.

Table 3 shows that there is the same perception between small and non-small qualifying contractor companies regarding the sequence suitability of readiness for implementation indicators for lean construction projects in Aceh Province for ranks 1–4. The indicator with the first ranking is the first attempt at process execution, where the conformity of readiness of small qualification contractor companies is 148.99% with a gap value of 1.281, while non-small qualifications are 146.15% with a gap value of 1.143. The indicator with the second-ranking is producing in small quantities, where the conformity of readiness of small qualified contractor companies is 144.59% with a gap value of 1.158, while non-small qualifications are 136.73% with a gap value of 0.857. The indicator with the third-ranking is prefabrication, where the conformity of readiness of small qualification contractor companies is 143.70% with a gap value of 1.035, while non-small qualifications are 125.45% with a gap value of 0.667. The indicator with the fourth-ranking is the work location layout design, where the suitability of the readiness of small qualification contractor companies is 118.95% with a gap value of 0.632, while non-small qualifications are 109.52% with a gap value of 0.286.

Table 3. Conformity of readiness and implementation differences lean construction according to the perception of small and non-small qualifying contractor companies partially.

No.	Lean construction Implementation Indicators	Contractor company					
		Small qualifications			Non small qualifications		
		TKi	Gap	Rank	TKi	Gap	Rank
1	Daily meetings with the workforce	101,41%	0,053	7	92,59%	-0,286	21
2	Prefabricated	143,70%	1,035	3	125,45%	0,667	3
3	Continuous improvement	96,31%	-0,140	19	87,95%	-0,476	29
4	Team preparation	93,83%	-0,246	24	90,48%	-0,381	25
5	Eliminate waste	96,92%	-0,123	16	92,86%	-0,286	20
6	Standardization of work to increase time efficiency	98,67%	-0,053	10	96,39%	-0,143	13
7	Analysis 5 whys to find the root cause of the problem	70,14%	-0,754	35	54,00%	-1,095	44
8	Total quality management	61,09%	-1,509	40	86,84%	-0,476	32
9	Visual management	61,43%	-1,509	39	83,75%	-0,619	35
10	First attempt at process execution	148,99%	1,281	1	146,15%	1,143	1
11	Error checking	98,58%	-0,053	11	94,87%	-0,190	16
12	Value stream mapping	93,24%	-0,263	26	86,90%	-0,524	31
13	Fishbone diagram to find the root cause of the problem	94,16%	-0,140	23	78,72%	-0,476	39
14	First-in, first-out material	105,66%	0,211	5	96,34%	-0,143	14
15	Analyze failure modes and impacts	65,37%	-1,246	36	80,39%	-0,476	38
16	Control the amount of material	100,00%	0,000	9	100,00%	0,000	9
17	The final planning system involves the involvement of many parties	42,67%	-2,263	46	41,25%	-2,238	45
18	Do a Pareto analysis to find out cause and effect	76,34%	-0,544	34	60,42%	-0,905	40
19	Implement the plan do check act cycle (plan, do, check, act)	97,77%	-0,088	14	105,06%	0,190	6
20	On-time delivery	88,53%	-0,439	29	88,61%	-0,429	28
21	5S process (sorting, organizing, cleaning, habituating, and disciplining)	96,36%	-0,140	18	98,73%	-0,048	12
22	Management commitment	82,11%	-0,684	32	87,18%	-0,476	30
23	Provide training courses in lean construction	62,67%	-1,421	37	81,71%	-0,714	37
24	Employ employees who have knowledge of lean construction	62,50%	-1,474	38	81,93%	-0,714	36
25	Effective communication	92,42%	-0,281	27	89,74%	-0,381	26
26	Cross-functional teamwork (collaboration)	93,81%	-0,228	25	93,51%	-0,238	19
27	Documentation of the implementation process	97,73%	-0,088	15	98,77%	-0,048	11
28	Plan implementation	100,93%	0,035	8	106,49%	0,238	5
29	Comparative studies with leading top companies	42,99%	-2,140	45	36,36%	-2,333	47
30	Quality and reliability of material suppliers	86,60%	-0,491	30	89,47%	-0,381	27
31	Building relationships with suppliers	96,70%	-0,123	17	94,87%	-0,190	17
32	Building relationships with owner	98,56%	-0,053	12	96,20%	-0,143	15
33	Using a supportive contract form lean construction	47,69%	-1,98	43	85,19%	-0,57	34
34	Worksite layout design	118,95%	0,632	4	109,52%	0,286	4
35	Workforce balancing	95,05%	-0,193	21	101,32%	0,048	7
36	Producing in small quantities	144,59%	1,158	2	136,73%	0,857	2
37	Reduction of supply chain processes	83,72%	-0,614	31	92,11%	-0,286	23
38	Reduction of working time	55,75%	-1,754	42	54,76%	-1,810	42
39	Work scheduling	103,76%	0,140	6	101,25%	0,048	8
40	Reduction of assembly processes	98,19%	-0,070	13	100,00%	0,000	10
41	Reduction of operational cycle costs	94,23%	-0,211	22	91,46%	-0,333	24
42	Increased efficiency and preservation of materials used in projects	44,29%	-2,140	44	54,55%	-1,667	43
43	Project waste reduction	89,30%	-0,404	28	92,21%	-0,286	22
44	Improved occupational health and safety	95,89%	-0,158	20	93,90%	-0,238	18
45	Saving energy and water used in the project	82,06%	-0,702	33	86,25%	-0,524	33
46	The building design is integrated with building information modeling (BIM)	38,32%	-2,316	47	36,84%	-2,286	46
47	Conservation of resources and environment	57,69%	-1,544	41	57,14%	-1,571	41

Readiness level is a classification of readiness of partially small and non-small qualifying contractor companies, which is useful as a follow-up that needs to be taken in the pre-evaluation process application of indicators lean construction. Results of evaluation of implementation readiness level lean construction on building construction projects in Aceh Province, according to the perception of small contractor companies the qualifications are as follows: 1) Quadrant A (important and not easy to implement): Quadrant A means implementation indicators lean construction has a high level of importance, while the level of convenience is low. In other words, application indicators lean construction has very low readiness, so it needs to be improved as a top priority. In this case, there are 11 indicators distributed in quadrant A, namely total quality management, visual management, final planning system through the involvement of many parties, providing training courses in lean construction, employing employees who have knowledge in lean construction, comparative studies with leading top companies, using supporting contract forms lean construction, reduction of working time, increased efficiency and preservation of materials used in the project, integrated building design with BIM, and conservation of resources and the environment. 2) Quadrant B (important and easy to implement): Quadrant B means implementation indicators of lean construction have an equally high level of importance and level of convenience. In other words, application indicators lean construction has very high readiness, so it needs to be maintained. In this case, there are 28 indicators distributed in quadrant B, namely daily meetings with the workforce, continuous improvement, team preparation, eliminating waste, standardizing work to increase time efficiency, error checking, value stream mapping, and first in and out materials. First, control the amount of material, implementing the plan do check act cycle, on-time delivery, 5S process (sorting, structuring, cleaning, customizing, and disciplining), management commitment, effective communication, cross-functional teamwork, implementation process documentation, planning implementation, quality and reliability of material suppliers, building relationships with suppliers, building relationships with owner, balancing work resources, reducing supply chain processes, work scheduling, reducing assembly processes, reducing operational cycle costs, reducing project waste, improving occupational health and safety, and saving energy and water used in projects. 3) Quadrant C (not important and not easy to implement): Quadrant C means implementation indicators of lean construction have an equally low level of importance and level of convenience. In other words, application indicators lean construction has low readiness, so it needs to be improved, which is included in the low priority. In this case, there are 4 indicators distributed in quadrant C, namely, an analysis of 5 whys to find the root cause of a problem, a fishbone diagram to find the root cause of a problem, an analysis of failure modes and impacts, and a Pareto analysis to find out cause and effect. 4) Quadrant D (not important and easy to implement): Quadrant D means implementation indicators of lean construction have a low level of importance and a high level of convenience. In other words, application indicators lean construction has excessive readiness, so it does not need to be increased further. In this case, there are 4 indicators distributed in quadrant D, namely prefabrication, first trial for process execution, work site layout design, and producing in small quantities.

Results of evaluation of implementation readiness level lean construction on building construction projects in Aceh Province, according to the perception of non-small contractor companies, the qualifications are as follows: 1) Quadrant A (important and not easy to implement): Implementation Lean construction whose readiness needs to be increased as a top priority, there are 6 indicators. These indicators are the final planning system through the involvement of many parties, comparative studies with top leading companies, reducing working time, increasing efficiency and preserving materials used in projects, integrated building design with BIM, and preserving resources and the environment. 2) Quadrant B

(important and easy to implement): Implementation Lean construction whose readiness needs to be maintained there are 33 indicators. These indicators are daily meetings with the workforce, continuous improvement, team preparation, eliminating waste, work standardization to increase time efficiency, total quality management, visual management, error checking, value stream mapping, first-in, first-out materials, control the amount of material, implementing the plan do check act cycle, on-time delivery, 5S process (sorting, structuring, cleaning, conditioning and disciplining), management commitment, providing training courses lean construction, employ employees who have knowledge in lean construction, effective communication, cross-functional teamwork, documentation of implementation processes, planning implementation, quality and reliability of material suppliers, building relationships with suppliers, building relationships with owner, using a supporting contract form lean construction, balancing work resources, reducing supply chain processes, work scheduling, reducing assembly processes, reducing operational cycle costs, reducing project waste, improving occupational health and safety, and saving energy and water used in projects. 3) Quadrant C (not important and not easy to implement): Implementation Lean construction whose readiness needs to be improved in low priority there are 4 indicators. The indicator is analysis 5whys to find the root cause of a problem, a fishbone diagram to find the root cause of a problem, an analysis of failure modes and impacts, and a Pareto analysis to find out cause and effect. 4) Quadrant D (not important and easy to implement): Implementation Lean construction There are 4 indicators whose readiness does not need to be increased. These indicators are prefabrication, first trial for process execution, work site layout design, and production in small quantities.

Personnel from small and non-small qualifying contractor companies in this study totaled 78 respondents. Characteristics of 78 personnel from small and non-small qualifying contractor companies, all of whom are male, predominantly aged 31-40 years, with a bachelor's degree, company position site engineer, and the number of building construction projects that have been built is 7–9 projects. Perceptions of small and non-small qualifying contractor company personnel simultaneously towards the level of importance and ease of implementation of lean construction have different evaluations. This is because a person's perception is influenced by subjective ways of thinking and feeling. These different perceptions can be accommodated through values mean, which is completed through descriptive statistics. Based on the simultaneous perception of qualified small and non-small contractor company personnel, modified IPA analysis can then be applied. The analysis of modified IPA in the context of this discussion aims to determine the percentage of suitability of readiness, the difference in readiness, and the level of readiness in implementing lean construction on building construction projects in Aceh Province according to the perception of small and non-small qualifying contractor companies simultaneously. Readiness suitability (TKi) is a condition where small and non-small qualifying contractor companies simultaneously perceive the level of ease as equal to the level of importance of implementing the indicators of lean construction. The difference in readiness (gap) is a difference in perception of small and non-small qualifying contractor companies simultaneously, between the level of ease and the level of importance of applying indicators of lean construction.[15-18] The suitability of readiness and the difference in readiness for implementation of lean construction on building construction projects in Aceh Province, according to the perception of small and non-small contractor companies, the qualifications simultaneously can be shown in Table 4.

Table 4. Conformity of readiness and implementation differences in lean construction according to the perception of small and non-small qualifying contractor companies simultaneously.

No.	Lean construction Implementation Indicators	Small and non-small qualified contractor companies		
		TKi	Gap	Rank
1	Daily meetings with the workforce	98,98	-0,038	10
2	Prefabricated	138,42	0,936	3
3	Continuous improvement	94,00	-0,231	21
4	Team preparation	92,93	-0,282	24
5	Eliminate waste	95,82	-0,167	19
6	Standardization of work to increase time efficiency	98,06	-0,077	12
7	Analysis 5whys to find the root cause of the problem	65,98	-0,846	40
8	Total quality management	67,68	-1,231	38
9	Visual management	67,33	-1,269	39
10	First attempt at process execution	148,26	1,244	1
11	Error checking	97,58	-0,090	15
12	Value stream mapping	91,50	-0,333	26
13	Fishbone diagram to find the root cause of the problem	90,22	-0,231	27
14	First-in, first-out material	103,06	0,115	6
15	Analyze failure modes and impacts	68,36	-1,038	35
16	Control the amount of material	100,00	0,000	8
17	The final planning system involves the involvement of many parties	42,30	-2,256	45
18	Do a Pareto analysis to find out cause and effect	72,07	-0,641	34
19	Implement the plan do check act cycle (plan, do, check, act)	99,67	-0,013	9
20	On-time delivery	88,55	-0,436	29
21	5S process (sorting, organizing, cleaning, habituating, and disciplining)	96,99	-0,115	16
22	Management commitment	83,45	-0,628	32
23	Provide training courses in lean construction	67,89	-1,231	36
24	Employ employees who have knowledge of lean construction	67,75	-1,269	37
25	Effective communication	91,70	-0,308	25
26	Cross-functional teamwork (collaboration)	93,73	-0,231	22
27	Documentation of the implementation process	98,01	-0,077	13
28	Plan implementation	102,39	0,090	7
29	Comparative studies with leading top companies	41,24	-2,192	46
30	Quality and reliability of material suppliers	87,37	-0,462	30
31	Building relationships with suppliers	96,21	-0,141	18
32	Building relationships with owner	97,92	-0,077	14
33	Using a supportive contract form lean construction	57,91	-1,60	41
34	Work site layout design	116,60	0,538	4
35	Workforce balancing	96,64	-0,128	17
36	Producing in small quantities	142,64	1,077	2
37	Reduction of supply chain processes	85,91	-0,526	31
38	Reduction of working time	55,48	-1,769	43
39	Work scheduling	103,07	0,115	5
40	Reduction of assembly processes	98,68	-0,051	11
41	Reduction of operational cycle costs	93,45	-0,244	23
42	Increased efficiency and preservation of materials used in projects	46,96	-2,013	44
43	Project waste reduction	90,07	-0,372	28
44	Improved occupational health and safety	95,35	-0,179	20
45	Saving energy and water used in the project	83,17	-0,654	33
46	The building design is integrated with building information modeling (BIM)	37,93	-2,308	47
47	Conservation of resources and environment	57,54	-1,551	42

Table 4 shows that according to the perception of small and non-small qualifying contractor companies simultaneously, there are 7 indicators that exceed readiness, 1 indicator that meets readiness, and 39 indicators that are far from readiness. The dominant indicator goes beyond implementation readiness lean construction on a building construction project in Aceh Province. The first trial for process execution was 148.26%, with a gap value of 1.244. Indicators that meet implementation readiness lean construction in building construction projects in Aceh Province, control of the amount of material is 100.00% with a gap value of 0.000. The dominant indicators moved away from a readiness for implementation of lean construction in building construction projects in Aceh Province; the integrated building design with BIM was 37.93%, with a gap value of -2.308.

Readiness level is a classification of readiness for small and non-small qualifying contractor companies simultaneously, which is useful as a follow-up that needs to be taken in the pre-evaluation process application of indicators lean construction. Results of evaluation of implementation readiness level lean construction on building construction projects in Aceh Province, according to the perception of small and non-small contractor companies, the simultaneous qualifications are as follows: 1) Quadrant A (important and not easy to implement): Implementation Lean construction whose readiness needs to be improved as a top priority, there are 11 indicators. These indicators are total quality management, visual management, final planning system through the involvement of many parties, providing training courses in lean construction, employing employees who have knowledge in lean construction, comparative studies with leading top companies, using supporting contract forms lean construction, reduction of working time, increased efficiency and preservation of materials used in the project, integrated building design with BIM, and conservation of resources and the environment. 2) Quadrant B (important and easy to implement): Implementation Lean construction whose readiness needs to be maintained there are 28 indicators. These indicators are daily meetings with the workforce, continuous improvement, team preparation, eliminating waste, standardizing work to increase time efficiency, error checking, value stream mapping, first-in-first-out materials, control of material quantities, and implementing cycles. plan do check act, on-time delivery, 5S process (sorting, structuring, cleaning, customizing and disciplining), management commitment, effective communication, cross-functional teamwork, implementation process documentation, planning implementation, quality and reliability of material suppliers, building relationships with suppliers, build relationships with owner, balancing work resources, reducing supply chain processes, work schedule, reducing assembly processes, reducing operational cycle costs, reducing project waste, improving occupational health and safety, and saving energy and water used in projects. 3) Quadrant C (not important and not easy to implement): Implementation Lean construction whose readiness needs to be improved in low priority there are 4 indicators. The indicator is analysis 5whys to find the root cause of a problem, a fishbone diagram to find the root cause of a problem, an analysis of failure modes and impacts, and a Pareto analysis to find out cause and effect. 4) Quadrant D (not important and easy to implement): Implementation Lean construction There are 4 indicators whose readiness does not need to be increased. These indicators are prefabrication, first trial for process execution, work site layout design, and production in small quantities.

4. Conclusion

Lean construction indicators are classified as important and not easy to implement in building construction projects in Aceh Province. According to the perception of small qualified contractor companies, there are 11 indicators, namely total quality management, visual management, final planning system through the involvement of many parties, providing training courses in lean construction, employing employees who have

knowledge in lean construction, comparative studies with leading top companies, using supporting contract forms lean construction, reduction of working time, increased efficiency and preservation of materials used in the project, integrated building design with BIM, and conservation of resources and the environment. Indicator Lean construction is considered important and not easy to implement on building construction projects in Aceh Province, according to the perception of non-small qualifying contractor companies, there are 6 indicators, namely the final planning system through the involvement of many parties, comparative studies with top leading companies, reduced working time, increased efficiency and preservation of materials used in projects, integrated building design with BIM, and conservation of resources and the environment. Indicator Lean construction which is considered important and not easy to implement on building construction projects In Aceh Province, according to the perception of small and non-small qualifying contractor companies (combined), there are 11 indicators, namely total quality management, visual management, final planning system through the involvement of many parties, providing training courses lean construction, employ employees who have knowledge in lean construction, comparative studies with leading top companies, using supporting contract forms lean construction, reduction of working time, increased efficiency and preservation of materials used in the project, integrated building design with BIM, and conservation of resources and the environment.

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