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Study of Key Success Factors for Lean Six Sigma and Last Planner System in Basement Work on High-rise Residential Building Projects, Jakarta Indonesia

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ABSTRACT

Currently, the construction of high-rise buildings is increasingly being carried out, in line with economic growth in big cities, but vacant land for settlements, offices and residential buildings is very little or limited, as well as the high price of land in cities. The level of housing needs in Indonesia. In Indonesia until 2025 it is estimated that it will require housing around 1,513,865 residential units. so that the need for residential units in cities is very large, to cope with limited land and high prices of land in the city, now to meet the residential needs, buildings are made vertically (highrise), but with limited land and rampant construction of high-rise buildings have an effect on the need for parking lots, to overcome this, a basement was made, which could be used as a parking area in addition to other functions such as utility rooms and others. In the implementation of high-rise building construction projects, good scheduling and quality control play a very important role, in the timeliness, cost and quality / quality of project completion as a whole [2]. The success of a construction project is based on 3 things, namely cost, quality and time. To control cost, quality and time in this study using the Lean Six Sigma and Last Planner System methods. By using this method, it will control waste (waste) and control scheduling so that work delays do not occur. To get the factors that affect cost efficiency, quality and time, researchers use analysis with SPSS software (Statistical Package for the Social Sciens), with SPSS 10 key success factors that can streamline costs, quality and time are obtained as follows: 1. Reduction costs, 2. Improve communication among project participants, 3. Knowledge of the project, 4. Planning Process, 5. Predictable Work Plan, 6. Prepare a weekly plan, 7. BoQ, 8. Image, 9. Damaged Soil Removal Method, 10. Weather Conditions. These 10 factors are expected to make cost, quality and time efficiency in construction implementation.

Key Words: Lean Six Sigma, Last Planner System, Statistical analysis.

1. INTRODUCTION

Currently, the construction of high-rise buildings is increasingly being carried out, in line with economic growth in big cities, but vacant land for settlements, offices and residential buildings is very little or limited, as well as the high price of land in cities. Based on the 2010-2035 Indonesian Population Projection report (Central Statistics Agency (BPS), n.d.), the current population of Indonesia in 2020 will reach 271.1 million people can be seen in the figure 1.

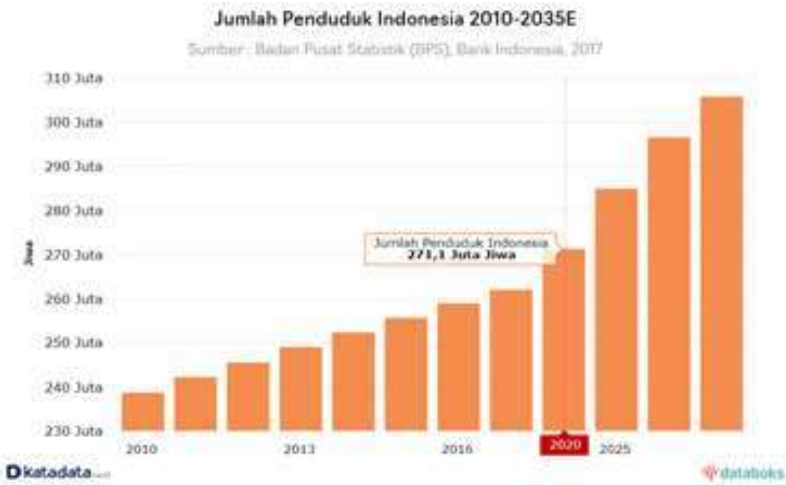

Figure 1 The population of people in urban areas [3]

To cope with limited land and high land prices in the city, to meet the residential needs a vertical building is made (highrise), the construction of a high-rise building has an effect on the need for parking space, to overcome this, a basement is made, which can be used as a parking space in addition to other functions. such as utility rooms and others, for the estimated residential needs from 2012 - 20125 it can be seen from the table 1.2

Figure 10: Annual average housing completions 2012–2025

India	11,507,476
China	9,326,381
Indonesia	1,513,865
US	1,485,966
Nigeria	1,484,362
Brazil	1,389,872

Figure 1.2 Housing needs in several countries [4]

According to [5] The cost of building a basement ranges from Rp. 6.0 million to Rp. 8.0 million, including foundation work and external works, as shown in the figure 1.3 :

JAKARTA CONSTRUCTION PRICES

DEVELOPMENT TYPE	COST PER CFA IDR ('000) / m²	COST PER CFA USD / m²
CARPARK		
Multi Storey	3,500 - 4,500	250 - 320
Basement outside CBD	4,000 - 6,000	280 - 420
Basement, CBD	6,000 - 8,000	420 - 570

Notes: Construction Floor Area (CFA) - The area of all building enclosed covered spaces measured to the outside face of external walls including covered basement and above ground car park areas.

All Jakarta construction prices stated herein are as at 3rd Quarter 2019 and include a general allowance for foundation and external works. The price ranges herein are indicative and due consideration should be given to the different specification, size, location and nature of each project when utilising this information. The prices here may not fully reflect the extent of current market forces and tendering conditions.

Exchange Rate Assumption: 1 USD = 14,119 IDR

Figure 1.3 Construction cost per m2 of basement

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According to [6] turner & townsend, for the construction cost of a basement around Rp. 5.5 million to Rp. 7.0 M, as can be seen in the table below:

International building costs per m² of internal area, in 2018	IDR	USD (exchange rate: 14,872)
Airports (Building only)		
Domestic terminal, full service	25,000,000	1,681
Low-cost carrier terminal, basic service	19,500,000	1,311
Car parks		
Multi-storey – above ground	5,500,000	370
Multi-storey – below ground	7,000,000	471
Commercial		
Offices – Business Park	9,000,000	605
CBD Offices – up to 20 floors medium (A-Grade)	11,500,000	773
CBD Offices – high-rise prestige	15,000,000	1,009
Education		
Primary and secondary	8,500,000	572
University	11,500,000	773
Hospitals		
Day centre (including basic surgeries)	16,000,000	1,076
Regional hospital	18,500,000	1,244
General hospital (e.g. city teaching hospital)	21,000,000	1,412
Hotels		
3 Star travellers	12,500,000	841
5 Star luxury	21,000,000	1,412
Resort style	26,000,000	1,748
Industrial		
Warehouse/factory units – basic	7,500,000	504
Large warehouse distribution centre	11,000,000	740
High-tech factory/laboratory	15,000,000	1,009
Residential		
Individual detached or terrace style house – medium standard	10,500,000	706
Individual detached house – prestige	13,000,000	874
Townhouses – medium standard	8,000,000	538
Apartments – low-rise medium standard	9,000,000	605
Apartments – high-rise	13,000,000	874
Aged care/affordable units	9,000,000	605

Figure 1.4 Construction cost per m2 of basement

So if we see from the three sources above (figures 1.3 to 1.4) that the costs for building a basement are quite expensive, so it is necessary to calculate and supervise very tightly, from planning to implementation, so that it can reduce both errors. a matter of time and waste (waste).

2. LITERATURE REVIEW

2.1 *Lean Six Sigma*

Lean Six sigma is a combination of lean and six sigma which can be defined as a business philosophy, systemic and systematic approach to identify and eliminate waste or activities that are not value added through radical continuous improvement to reach the six sigma level. (six sigma). The Six Sigma methodology uses statistical tools to identify several vital factors. The most determining factors to improve process quality and generate profit consist of 5 stages called DMAIC (define, measure, analyze, improve, control) [7], as shown in figure 1.5 :

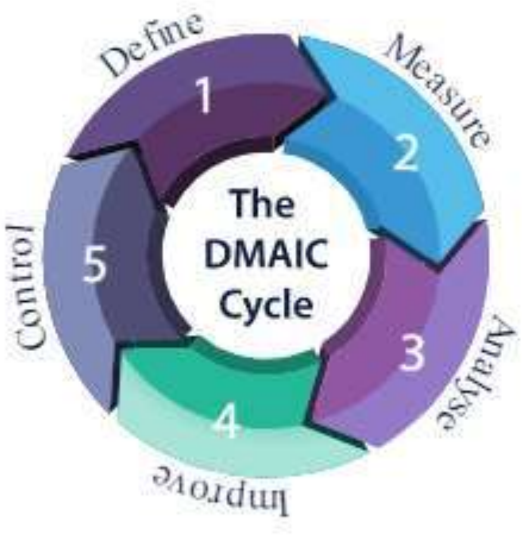

Figure 1.5 Six Sigma Cycle [8]

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2.2 *Last Planner System (LPS)*

Special emphasis is placed on the relationship between production scheduling and control, and also on phase planning techniques to determine when work can escape constraints or obstacles which are the focus of Last Planner (Lean construction Indonesia 2020). Lean Construction is about building projects while providing value, minimizing waste and achieving excellence for the benefit of all stakeholders [9]. The benefits of Lean Construction techniques have been demonstrated by achieving the improvement of multiple projects and each stage of the project. Lean Construction takes more time in the design and planning stages, but this attention eliminates or minimizes conflicts that can dramatically change costs and schedules [10].

2.2.1 Work Flow Control LPS

In this system, there are performance indicators that are used to measure the extent to which work flow can be achieved properly, as for the Last Planner System work flow control, namely:

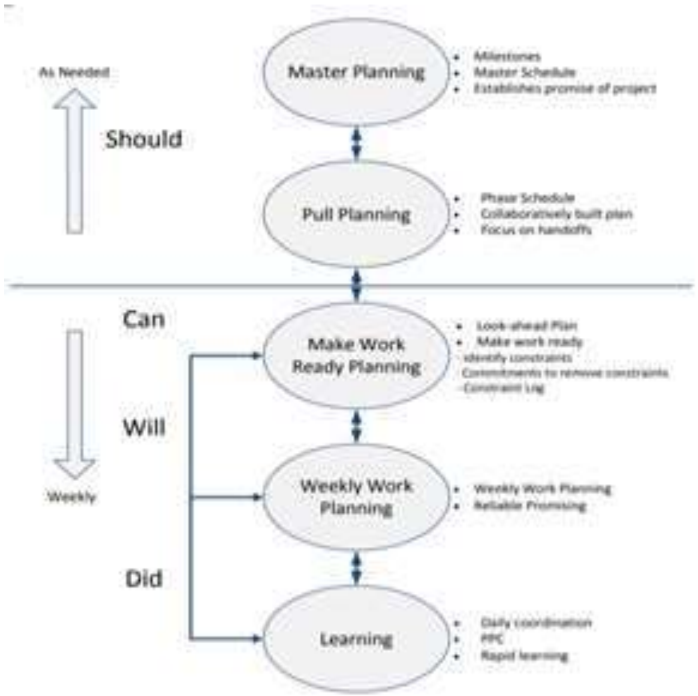

Figure 1.6 Last Planner System Process [11]

- Master Plan *(Master Planning)*

  To get a general plan and identify all work for the whole project show the main activities, duration, and sequence.

- *Pull Planning*

  The function of the planning phase is to produce a detailed schedule that includes each phase of the project as a foundation in determining further planning, structural framework, and finishing. In making this planning phase, it is more profitable if it is done with a team. [12].

- *Lookahead Planning (Make Work Ready Planning)*

  Lookahead planning describes the first step of LPS planning with a duration typically ranging from two to six weeks. At this stage, activities are broken down to the process / operation level, constraints are identified, job responsibilities are assigned to each person (implementation), and work assignments are ready to be carried out. [13].

- *Weekly Work Planning (WWP)*

  WWP directly illustrates the relationship between job tasks to drive the production process. At the end of each period, monitoring and evaluation is carried out to analyze whether the plans made were effective, and what obstacles were faced [14].

- *Percent Plan Complete (PPC)*

  PPC is the number of assignments that have been completed divided by the number of all assignments planned, and written as a percentage (H. G. Ballard, 2000). The equation is as follows:

$$PPC\ (\%) = \frac{\text{The number of work plans performed successfully}}{\text{Total Work Plan}} \times 100 \quad \ldots\ldots(1)$$

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2.3 ***Basement***

Basement is a vertical downward development that creates an underground space (Basement) which is part of the building. Basement implementation method according to [15] There are 3 methods, namely the open cut method, the bottom up method and the top down method, as follows:

Figure 1.7 Basement Implementation Method

2.4 ***Bore Pile***

Bored pile foundation is a pile foundation whose installation is done by drilling the ground first [16]. Bored pile foundation is one type of foundation which is part of the construction made of concrete and steel reinforcement [17]. For the drilling method, it can be used with the dry boring method, or you can also use the wash boring technique.

2.5 ***Secant Pile***

Secant Pile is a Soil Retaining Wall which is included in the In-situ type which is used in narrow areas because this method does not require water. According to [18] secant pile in its implementation requires more concrete material and reinforcement and requires a longer time than concrete sheet pile. Secant pile can also be applied to soils with difficult conditions or high groundwater levels

2.6 ***Excavation***

Excavation or excavation is one of the stages in earthworks [19].

3. RESEARCH METHODOLOGY

This research process contains a research flow from the beginning to finding a hypothesis to answer the problem formulation by conducting scientific research, where in the process there are stages / sequences that are adjusted to the research framework that has been compiled in the form of a flow chart. The flow chart is prepared based on the formulation and research objectives to be achieved by referring to the project feasibility study [20].

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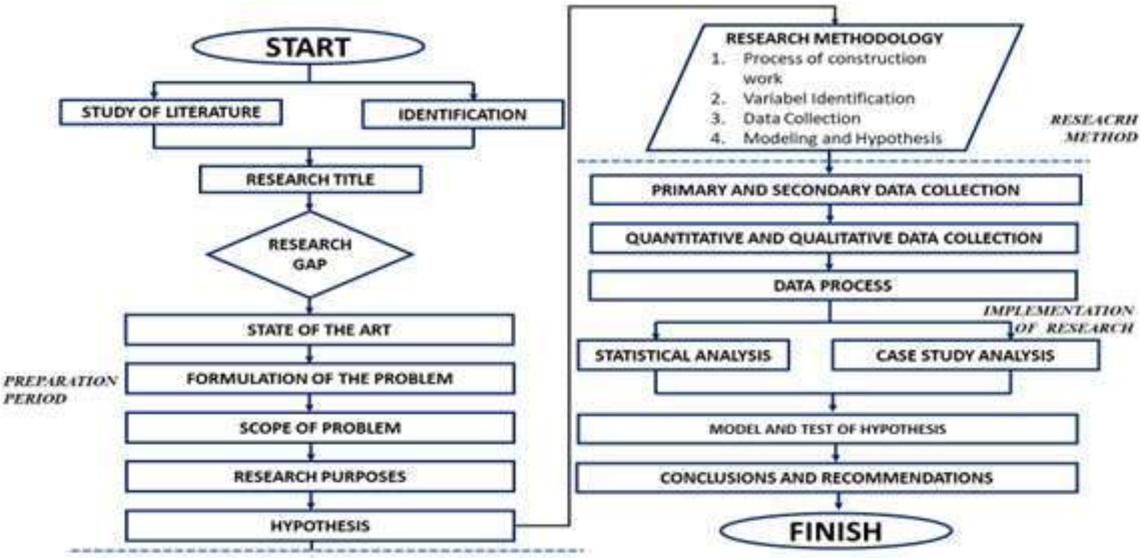

Figure 1.8 Research Flow

The data that has been collected is continued by processing and analyzing the data to get the initial data results. From the findings of these preliminary data, discussion analysis processing is then carried out to be able to draw conclusions about the process of cost, quality and time efficiency.

3.1 Variable Identification

In this case the researcher takes 2 (two) main variables to get cost efficiency and time accuracy as independent variables, and 3 (three) variables as dependent. The variables are:

Independent Variable : X1 = Lean Six Sigma

X2 = Last Planner System

X3 = Basement

Dependent Variable: Y1 = Cost

Y2 = Time

The identification of sub variables related to cost performance, quality and project time consists of 5 variables, namely Lean Six Sigma, Last Planner System, Time and Cost Basement. The number of respondents used in this study was 51 respondents. The following factors affect the increase in cost, quality and time performance.

Table 1.1 Key Success Factors

No	Variable	Main Factor	Sub Factor		Reference
1	Lean Six Sigma (X1)	Define	X1-1	Cost reduction	Jeyaraman (2010), Emerald
			X1-2	Elimination or reduction of waste	Jeyaraman (2010), Emerald
			X1-3	Product quality	Jeyaraman (2010), Emerald
			X1-4	Productivity	Jeyaraman (2010), Emerald
			X1-5	Flexibility	Jeyaraman (2010),Emerald
		Measure	X1-6	Material use and storage systems	Weisheng Lua, Hongping Yuanb,(2010)
			X1-7	Fewer design changes	Weisheng Lua, Hongping Yuanb,(2010)
			X1-8	Improve communication among project participants	Weisheng Lua, Hongping Yuanb,(2010)
			X1-9	Waste Management Regulations	Weisheng Lua, Hongping Yuanb,(2010)
		Analyze	X1-10	Knowledge of the project	(Schön et al., 2010)
			X1-11	The whole process of Aligning the agenda involved	(Schön et al., 2010)

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Table 1.1 Key Success Factors

No	Variable	Main Factor	Sub Factor		Reference
1	Lean Six Sigma (X1)	Analyze	X1-12	Project leaders lack understanding of the process	(Schön et al., 2010)
			X1-13	Availability of experts	(Schön et al., 2010)
			X1-14	Availability of "people who are suitable in their fields"	(Schön et al., 2010)
		Improve	X1-15	Supported operating system	J.P. Verma (2012)
			X1-16	Application updates	J.P. Verma (2012)
			X1-17	Supported PC devices	J.P. Verma (2012)
		Control	X1-18	Level of Defects in the Work Process	Nascimento (2019), Emerald
			X1-19	Evaluating Quality	Nascimento (2019), Emerald
			X1-20	Reduction of Variability	Nascimento (2019), Emerald
2	Last Planner System (X2)	Planning	X2-1	predictable work plan	Aziz (3013), Alexandria Engineering Journal
			X2-2	reduce project delivery time	Aziz (3013), Alexandria Engineering Journal
			X2-3	increased productivity	Aziz (3013), Alexandria Engineering Journal
		Supporting Implementa tion	X2-4	Production process	(Tayeh, Al Hallaq, Al Faqawi, Alaloul, & Kim, 2018)
			X2-5	Planning process	(Tayeh et al., 2018)
			X2-6	Eliminates Waste In Your Workflow	(Tayeh et al., 2018)
			X2-7	Level of Defects in the Work Process	(Tayeh et al., 2018)
		Weekly Planning	X2-8	prepare a weekly plan	AlSehaimi (2014) Emerald
			X2-9	Identify reasons for incomplete	AlSehaimi (2014) Emerald
			X2-10	Calculating PPC	AlSehaimi (2014) Emerald
			X2-11	Perform a constraint analysis	AlSehaimi (2014) Emerald
3	Basement (X3)	Tender document	X3-1	technical specifications	Husin et al (2019)
			X3-2	BoQ	Husin et al (2019)
			X3-3	Time	Husin et al (2019)
		Preparatory work	X3-4	Picture	Tarek M. Zayed and Daniel W. Halpin (2004)
			X3-5	Soil type (e.g., sand, loam, rigid loam)	Tarek M. Zayed and Daniel W. Halpin (2004)
			X3-6	Drill type, size and construction method	Tarek M. Zayed and Daniel W. Halpin (2004)
			X3-7	The soil removal method is damaged	Tarek M. Zayed and Daniel W. Halpin (2004)
			X3-8	Hole depth and size	Tarek M. Zayed and Daniel W. Halpin (2004)
			X3-9	Weather conditions	Tarek M. Zayed and Daniel W. Halpin (2004)
4	Cost (Y1)	Cost	Y1-1	Bad Design and Delays in Design	Hamed Samarghandi et al.(2016)
			Y1-2	Unrealistic contract duration	Hamed Samarghandi et al.(2016)
			Y1-3	Lack of experience	Hamed Samarghandi et al.(2016)
			Y1-4	Late delivery of materials and equipment	Hamed Samarghandi et al.(2016)
			Y1-5	The relationship between management and labor	Hamed Samarghandi et al.(2016)

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Table 1.1 Key Success Factors

No	Variable	Main Factor	Sub Factor		Reference
4	Cost (Y1)	Cost	Y1-6	Delays Preparation and approval of drawings	Hamed Samarghandi et al.(2016)
			Y1-7	Inadequate planning and scheduling	Hamed Samarghandi et al.(2016)
			Y1-8	Poor site management and supervision	Hamed Samarghandi et al.(2016)
			Y1-9	Error during construction	Hamed Samarghandi et al.(2016)
			Y1-10	Changes to specifications and material types	Hamed Samarghandi et al.(2016)
5	Time (Y2)	Time	Y2-1	Unforeseen weather	Seyed Mohammad Moosavi . At all (2016)
			Y2-2	Inaccurate predictions of artisan production levels	Seyed Mohammad Moosavi . At all (2016)
			Y2-3	Lack of material	Seyed Mohammad Moosavi . At all (2016)
			Y2-4	Lack of equipment	Seyed Mohammad Moosavi . At all (2016)
			Y2-5	Lack of skilled workforce	Seyed Mohammad Moosavi . At all (2016)
			Y2-6	Project location restrictions	Seyed Mohammad Moosavi . At all (2016)
			Y2-7	Poor labor productivity	Seyed Mohammad Moosavi . At all (2016)
			Y2-8	Design changes	Abd El-Razek, Bassioni and Mobarak (2008)

3.2 Determination of Number of Respondents

The minimum number of respondents to answer the questionnaire is needed as a limitation in collecting the required results. According to [21] Respondents' needs can be obtained using the following equation:

$$m = \frac{Z^2 \times P \times (1-P)}{\varepsilon^2} \text{..............................} (2)$$

$$n = \frac{m}{1 + \frac{(m-1)}{N}} \text{..............................} (3)$$

Where : N = 58, ε = 0,05, P = 0,5

$$p - \text{value} = \frac{1-\varepsilon}{2} = \frac{1-0{,}05}{2} = 0{,}475$$

Based on value p-value is obtained by the Z value based on the normal distribution Z table, Z = 1.96. Then the minimum respondent needs are as follows:

$$m = \frac{Z^2 \times P \times (1-P)}{\varepsilon^2} = m = \frac{1{,}96^2 \times 0{,}5 \times 0{,}5}{0{,}05^2} = \frac{0{,}96}{0{,}0025} = 384{,}16$$

$$n = \frac{m}{1 + \frac{(m-1)}{N}} = n = \frac{384{,}16}{1 + \frac{(384{,}16-1)}{58}} = \frac{384{,}16}{7{,}61} = \mathbf{50{,}5061}$$

Therefore, the minimum requirement for respondents is 51 respondents

3.3 Data Processing Stage

In testing the validity of a measure that can show the validity or validity of the instrument. So in testing the validity it refers to an instrument in carrying out its function. Variables obtained from published journals, articles and e-books. The process of testing the validity and reliability is carried out using the following tools in the SPSS program, which is a data processing flowchart:

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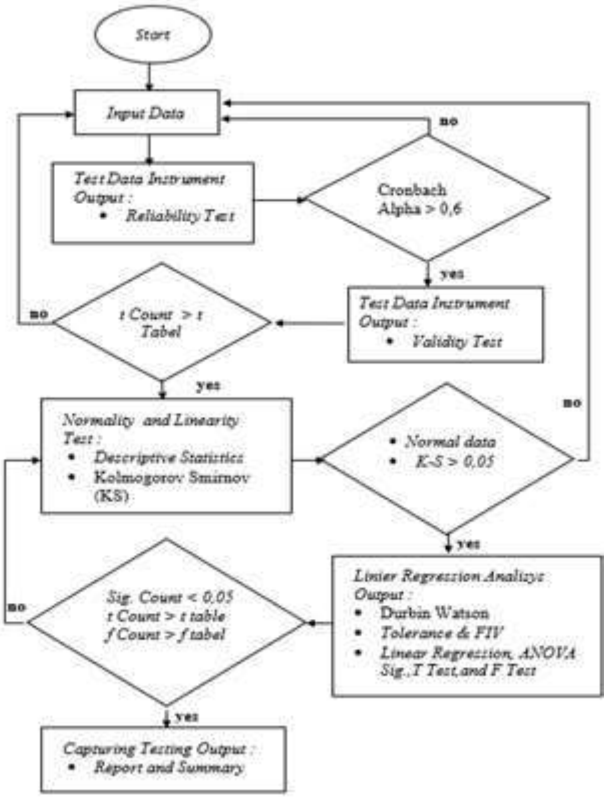

Figure 1.9 ***Flowchart SPSS*** **[22]**

3.4 Validity Test and Reliability Test

From each variable will be tested using SPSS tools, namely the value of the corrected item total correlation (calculated validity) if the value is more than 0.2542 then it can be stated as valid and the value of Cronbach's Alpha (Calculated Reliability). If the value is more than 0.600 then can be stated as realistic, here are the results of data grouping that are both realistic and valid. [23]

Table 1.2 Validity Test Results

Variable	Alpha Cronbach	Comparative Value	Remark
Lean Six Sigma	0.401	0.2542	Valid
Last Planner System	0.627	0.2542	Valid
Basement	0.549	0.2542	Valid
Cost	0.526	0.2542	Valid
Time	0.577	0.2542	Valid

Table 1.3 Reliability Test Result

Variabel	Alpha Cronbach	Comparative Value	Keterangan
Lean Six Sigma	0.722	0.600	Reliabel
Last Planner System	0.841	0.600	Reliabel
Basement	0.719	0.600	Reliabel
Cost	0.707	0.600	Reliabel
Time	0.722	0.600	Reliabel

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The results of the average analysis are then compiled into a recapitulation which is presented in the form of sub-factor rankings. The results of the recapitulation of statistical analysis using the average method, more details can be seen in the discussion below.

Rank	Sub Factor	Main Factor
1	Cost reduction	Define
2	Improve communication among project participants	Measure
3	Knowledge of the project	Analyze
4	Planning process	Supporting implementation
5	predictable work plan	Planning
6	prepare a weekly plan	Weekly Planning + make ready
7	BoQ	Tender document
8	Bad Design and Delays in Design	Cost
9	Picture	Preparatory work
10	Error during construction	Cost
11	The soil removal method is damaged	Preparatory work
12	Lack of skilled workforce	Time
13	Weather conditions	Preparatory work
14	Unforeseen weather	Time
15	Flexibility	Define
16	Project leaders lack understanding of the process	Analyze
17	Fewer design changes	Measure
18	Availability of experts	Analyze
19	reduce project delivery time	Planning
20	Poor labor productivity	Time
21	Identify reasons for incomplete	Weekly Planning + make ready
22	Soil type (e.g., sand, loam, rigid loam)	Preparatory work
23	Inadequate planning and scheduling	Cost
24	Lack of material	Time
25	Availability of "people who are suitable in their fields	Analyze
26	Design changes	Time
27	The whole process of Aligning the agenda involved	Analyze
28	Supported PC devices	Process
29	Lack of equipment	Time
30	Unrealistic contract duration and terms imposed	Cost
31	The relationship between management and labor	Cost
32	Project location restrictions	Time
33	Elimination or reduction of waste	Define
34	Evaluating Quality	Improve
35	Production process	Supporting implementation
36	Productivity	Define
37	technical specifications	Tender document
38	Level of Defects in the Work Process	Improve
39	increased productivity	Planning
40	Perform a constraint analysis	Weekly planning + make ready
41	Changes to specifications and material types	Cost
42	Application updates	Process
43	Material use and storage systems	Measure
44	Time	Tender document
45	Lack of experience	Cost
46	Drill type, size and construction method	Preparatory work
47	Late delivery of materials and equipment	Cost
48	Eliminates Waste In Your Workflow	Supporting implementation
49	Calculating PPC	Weekly planning + make ready
50	Delays Preparation and approval of drawings	Cost
51	Reduction of Variability	Improve
52	Poor site management and supervision	Cost
53	Hole depth and size	Preparatory work
54	Waste Management Regulations	Measure
55	Product quality	Define

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56	Supported operating system	Process
57	Level of Defects in the Work Process	Supporting implementation
Rank	Sub Factor	Main Factor
58	Inaccurate predictions of craftsmen production levels	Time

4. CONCLUSION

The factors that greatly influence cost performance, quality, time are obtained from the processing of SPSS which has the highest index, namely:

1. Cost reduction
2. Improve communication among project participants
3. Knowledge of the project
4. The planning process
5. Predictable work plan
6. Prepare a weekly plan
7. BoQ
8. Bad design and delay in design
9. Image
10. Errors during construction

REFERENCE

[1] International Labour Organization. (2013). Global employment trends 2013. In *Global Employment Trends*.

[2] Soeharto I, (1995), *Project Management from Conceptual to Operational, Erlangga, Jakarta.*

[3] Badan Pusat Statistik. (2013). Statistik Indonesia 2013. In *Katalog BPS*.

[4] International Labour Organization. (2013). Global employment trends 2013. In *Global Employment Trends*

[5] Ali, M. M., & Moon, K. S. (2007). Structural Developments in Tall Buildings: Current Trends and Future Prospects. Architectural Science Review, 50(3), 205–223. https://doi.org/10.3763/asre.2007.5027

[6] Turner & Townsend. (2015). International construction market survey 2016. *Global Rebalancing: A Changing Landscape*.

[7] Husin, A. E. (2019). Application of PERT and Six Sigma integration on building pile foundation. *International Journal of Civil Engineering and Technology*.

[8] Evans, J. R., & Lindsay, W. M. (2008). The Management and Control of Quality. *The Management and Control of Quality*.

[9] Pinch, L. (2005). Lean Construction: Eliminating the Waste. *Construction Executive, November*, 34–37. http://www.ncbi.nlm.nih.gov/pubmed/21174905

[10] Forbes, L., & Ahmed, S. (2004). Adapting lean construction methods for developing nations. *Proceedings of the 2nd Latin American and …*.

[11] Ballard, G., & Howell, G. (2003). An update on last planner. *11th Annual Conference of the International Group for Lean Construction*.

[12] Last Planner®. (2014). In *Handbook for Construction Planning and Scheduling*. https://doi.org/10.1002/9781118838167.ch7

[13] Hamzeh, F. R., & Aridi, O. Z. (2013). Modeling the Last Planner System metrics: A case study of an AEC company. *21st Annual Conference of the International Group for Lean Construction 2013, IGLC 2013*.

[14] Howell, G. A., Ballard, G., Tommelein, I. D., & Koskela, L. (2004). Discussion of "Reducing Variability to Improve Performance as a Lean Construction Principle" by H. Randolph Thomas, Michael J. Horman, Ubiraci Espinelli Lemes de Souza, and Ivica Zavřski. *Journal of Construction Engineering and Management*. https://doi.org/10.1061/(asce)0733-9364(2004)130:2(299)

[15] Fathurohman, W. A., Wulan, A., & Handayani, T. (2015). Methods of Implementation and Calculation of Material

DOI : 10.31695/IJERAT.2021.3700

Requirements for Pile Cap on the Basement Floor. Electronic Journal.

[16] Hardiyatmo, H. C. (2006). Soil Mechanics II Edition 3. In Gadjah Mada University Press.

[17] C. Harsanto, F.J. Manoppo, J.R. Sumampouw. (2015). *Scientific Journal of Media Engineering,* vol 5 No. 2, 345-350, ISSN 2087-9334.

[18] Anderson, S. (2012). Types of retaining walls. *ICE Manual of Geotechnical Engineering Volume 2: Geotechnical Design, Construction and Verification*.

[19] Galler, R. (2017). Excavation. In *Rock Mechanics and Engineering Volume 4: Excavation, Support and Monitoring*. https://doi.org/10.1201/b20406

[20] Semiawan, P.D. 2010. *Qualitative Research Methods Types, Characteristics, and Advantages. Jakarta: Grafindo.*

[21] Alaghbari, W., Kadir, M. R. A., Salim, A., & Ernawati. (2007). The significant factors causing delay of building construction projects in Malaysia. *Engineering, Construction and Architectural Management*. https://doi.org/10.1108/09699980710731308

DOI : 10.31695/IJERAT.2021.3700