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Influential factors in the application of the Lean Six Sigma and time-cost trade-off method in the construction of the ammunition warehouse

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Abstract
Construction projects have developed so rapidly, one of which is the construction of warehouses. The warehouse discussed in this study is an ammunition warehouse. The construction of the ammunition warehouse has a deadline in accordance with the contract agreed between the owner, contractor and consultant. But in the implementation in the field, there was a delay in the work of the concrete structure. This study aims to obtain the dominant factors causing delays in the ammunition warehouse project by applying the Lean Six Sigma method and time-cost trade-off in solving the problem. Data processing used statistical analysis SPSS (Statistical Package for the Social Sciences), which was obtained from questionnaires filled out by experts. From this processing, the highest ten factors were obtained, namely 1. Inadequate planning and scheduling, 2. Implementation of work plans, 3. Delay in drawing up and approval of drawings, 4. Cost reduction, 5. Relationship between management and labor, 6. Relationship design internal team, 7. Lack of skilled manpower, 8. Flexibility, 9. Errors during construction and 10. Inaccurate prediction of craftsman production levels. This research is useful and beneficial for readers and can be developed again.

Keywords:
Ammunition Warehouse;
Cost Performance;
Lean Six Sigma;
Time-cost trade-off;

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INTRODUCTION

The current population growth in a region is increasing [1]. Therefore, adequate warehouse management is essential to create cost reduction, space optimisation, and the time until the order picking, as shown in Figure 1 [2]. Currently, warehouse costs in Indonesia are relatively higher compared to several other countries, amounting to 9.47% of Gross Domestic Product [3]. In comparison, the contribution of warehousing costs in the United States is 2.8% [2], India at 3.8%, Brazil is estimated to a maximum of 4.1% [4], China at 6.3%, and Thailand is estimated at 7,6% [5]. If presented in graphical form, the data above is shown in Figure 2.

In general, the implementation of the ammunition warehouse has a deadline, where the project must be completed before or on time in accordance with the agreed contract. However, in its implementation, it is not easy. There is often a mismatch between the schedule that has been made with the reality in the field caused by several factors that have an impact on project delays which indirectly cause cost overruns. According to [6], from the research results on several construction projects in Saudi Arabia, only 30% of projects can be completed on time, while the rest experienced delays. In addition to having an impact on cost overruns, delays also provide other impacts.

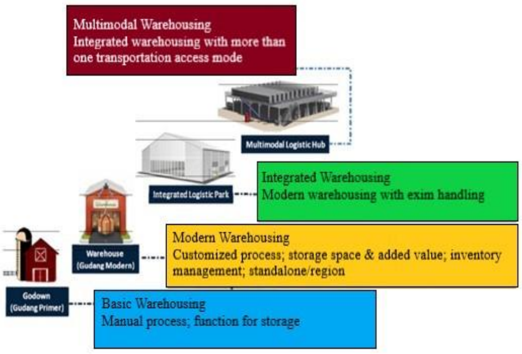

Figure 1. The direction of Warehousing Infrastructure Development

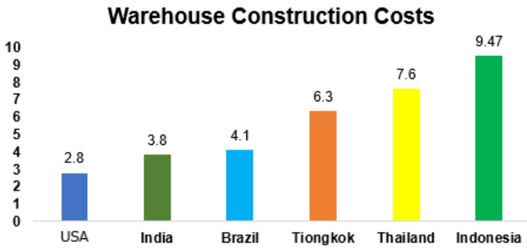

Figure 2. Graph of Percentage of Warehouse Construction Costs to Gross Domestic Product

According to Messah et al., delays in construction projects can cause various forms of loss for service providers and users services [7]. For example, delays result in lower credibility of service providers in the future for service providers. Meanwhile, for service users, delays can cause disputes and claims between service providers and service users.

As for what causes delays on construction projects, including bad weather, inaccuracy of work planning, identification of duration and incomplete and poorly structured work plans, quality of manpower, poor work, wrong construction methods, changing scope of work etc. Considering that the adverse effects caused by the delay are quite a lot, then efforts to reduce it are very necessary, but the achievement of this goal will not work well if these efforts are carried out sporadically, without first knowing the dominant variables causing delays.

Variable analysis in this study uses the application of Lean Six Sigma, which focuses on process improvement. Using the data obtained, it can be known what is wrong with the work system in the project. So, that it can identify the location and cause of the problem and action can be taken immediately to eliminate it. The time-cost trade-off that focuses on alternatives in accelerating implementation time in the field is expected to explain the important factors that affect the delay in the implementation of the ammunition warehouse construction, these variables are processed using statistical analysis with SPSS tools obtained from the validation of experienced experts and have applied the Lean Six Sigma method in improving quality [8] and time cost trade off in time efficiency of implementation. of these factors will affect both in terms of cost, quality and implementation time. This research can be useful for readers carrying out construction or those just in the planning stage to immediately take an alternative if there is a delay with the same factors.

MATERIAL AND METHOD

Material

Quality, according to the International Organization for Standardization (ISO), defines quality as the totality of features and characteristics of a product or service that relies on its ability to consistently meet the needs of companies, markets, and customers. Quality control is implemented by continuous monitoring and checking to ensure that the system is running effectively. So, it is not recommended to carry out quality control only within a certain period which has a long distance between the pre-inspection and the next one.

This is done to maintain that product quality can be monitored both in terms of quality and accuracy. In addition, proper documentation of inspections and test results is essential for analysing and reporting the source of defects so that steps can be taken to reduce defects. Documentation can be prepared for the entire production cycle, as illustrated in Figure 3.

Six Sigma is one of the methods currently being developed in the world. The Six Sigma method is a process that applies statistical tools and defect reduction techniques until it is defined as no more than 3.4 defects out of one million opportunities to achieve total customer satisfaction. Six Sigma provides added value for customers and stakeholders by focusing on improving the quality and productivity of the company [9].

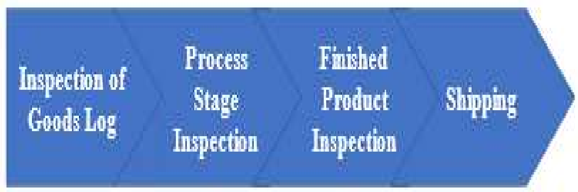

Figure 3. Steps to reduce defects

Six Sigma uses statistical tools to identify several vital factors. Lean Six Sigma is a combination of Lean and Six Sigma, which is a systematic approach to eliminating waste or activities that have no value-added through continuous improvement to reach the level six sigma performance, as shown in Figure 4. The basic principles of Lean Six Sigma are as follows:

1. Identify the value of the product (goods and/or services) based on the customer's perspective, where the customer wants superior quality products (goods and/or services) at competitive prices and on time delivery.
2. Identify the value stream process mapping (mapping the process on the value stream) for each product (goods and/or services).
3. Eliminate non-value-added waste from all activities throughout the value stream process.
4. Organising so that materials, information, and products flow smoothly and efficiently throughout the value stream process using a pull system.
5. Constantly looking for various improvement tools and techniques to achieve excellence and continuous improvement. The most responsible factor for improving process quality and generating profits consists of five stages called DMAIC (define, measure, analyse, improve, control). The following explains the stages of DMAIC in Six Sigma [10].

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. By flowing products and information using a pull system (Pull) from internal and external customers to pursue excellence and excellence by producing only 3.4 defective products for every one million opportunities or productions.

Time-Cost Trade-Off It often happens that a project must be completed faster than usual. In this case, the project leader is faced with the problem of how to speed up project completion with minimum costs. Therefore, it is necessary to study the relationship between time and cost. The time-cost trade-off analysis is called the Time-Cost Trade-Off.

Time cost trade-off is schedule compression to get more profitable projects in terms of time (duration), costs, and revenues. The goal is to compress the project with a duration acceptable and minimise the project's total cost.

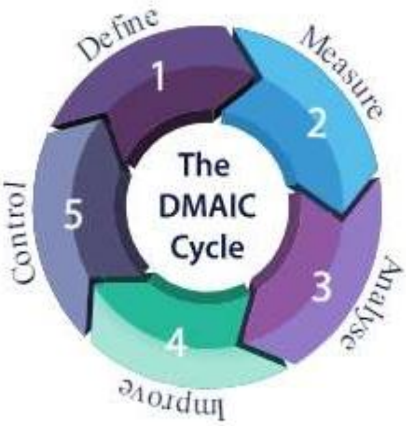

Figure 4. Six Sigma Cycle

Project duration reduction is carried out by choosing certain activities that are on the critical path. Project scheduling is one of the elements of planning outcomes, which can provide information about the plan's schedule and progress project in terms of resource performance in the form of costs, labor, equipment and materials and plans project duration and time progress to project completion. Times cost trade-off is a process intentional, systematic and analytic by conducting tests of all activities in a project centered on activities that are on the critical path [9].

The compression steps can be written as follows [11]:

1. Development of the project network by writing down the cost slope of each activity.
2. Compression of activities that are on the critical path and have a cost slope
3. Reorganisation of the project network.
4. Repeating the second step, the second step will stop if there is an increase in the critical path, and if there is more than one critical path, the second step is carried out simultaneously on all critical paths, and the cost slope calculation is added.
5. Stop the compliance step if there is a critical path where the activity is completely saturated (no longer possible to suppress) to optimise cost control.

Cost estimation plays an important role in project implementation. It is used to find out how much it will cost to build a project or investment in the early stages. The next stage has the function to plan and control resources such as materials, labor, and time.

Estimating project costs has a different emphasis for each project participant organisation. For the owner, the estimated cost will be one of the benchmarks for determining the continuation of the investment. For contractors, the financial benefits that will be obtained depending on their ability to estimate costs. As for the consultant, the estimated cost is submitted to the owner to recommend the best amount of costs to realise the desired project. A cost estimate will be complete if it contains the following elements [12]: Cost of purchasing materials and equipment, Cost of financing or purchasing construction equipment, Wages of labor, Subcontractor costs, Transportation costs, Overhead and administrative costs and Costs/profits and contingencies

Method

This research is descriptive quantitative research, with the type of research is the survey method. The descriptive method is a method used to analyse data by describing or describing the data that has been collected as it is without intending to make generalised conclusions or generalisations.

This study will use two types of data, namely; Primary data, which is obtained from questionnaire surveys and focus group discussions as well as secondary data, which is obtained from the results of literature studies such as books, references, journals, and other research related to the research being carried out. The questionnaire survey was distributed to respondents through distribution both offline.

This research process contains a research flow from the beginning to get the important factors that affect the delay in the construction of the ammunition warehouse project. The flow chart is arranged based on several stages explained in Figure 5 [13].

The data that has been collected is continued by processing and analysing the data to obtain preliminary data results. From the findings of these preliminary data, discussion analysis processing is then carried out to be able to conclude the key success factors using the Lean Six Sigma method and Time-Cost Trade-Off to obtain optimisation and efficiency of time, cost, and quality [14].

RESULTS AND DISCUSSION

The process of processing data is described and analysed statistically Statistical Package for the Social Sciences (SPSS) [15] and found things - things, and influencing factors. In this discussion, the researcher will explain the factors that influence time and cost performance improvement based on Lean Six Sigma and Time-Cost Trade-Off in ammunition warehouse work.

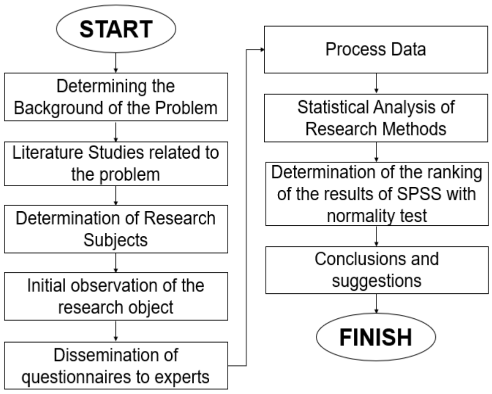

Figure 5. Research Flow

In determining the factors that affect the research object, the author uses the average statistical analysis method. Statistical calculations process this analysis method with the questionnaire results as input which will later be processed into influencing factors.

The average method determines the most influential factors with a ranking system based on the weight of the scores given from the respondents after filling out the questionnaire. The average method is operated using the Microsoft Excel 2013 [16] application program, while the average analysis results will be carried out several tests such as validity, reliability, regression equations, and hypothesis testing H1 and H0. Figure 6 show the stages and results of the average statistical analysis in this study.

The data that must be input is data resulting from the preparation of questionnaires obtained from literature studies (international journals, e-books, national journals and related books) to obtain key success factors or critical points of the discussion material, which is used as a component of the questionnaire such as the main factor and sub factor variables. Next, collect them into a form of a list of questions that will be asked to respondents who have been calculated using the Slovin method.

There are three variables and three main factors in the study: Variable, Main Factor, and Sub Factor.

Variable

There are two types of variables: Independent Variables and Dependent Variables. In Independent Variables, there is Implementation of Lean Six Sigma (X1), Implementation of Time-Cost Trade-Off (X2) and Ammunition Warehouse Job (X3). However, Cost Performance (Y1) and Time Performance (Y2) are the dependent variables.

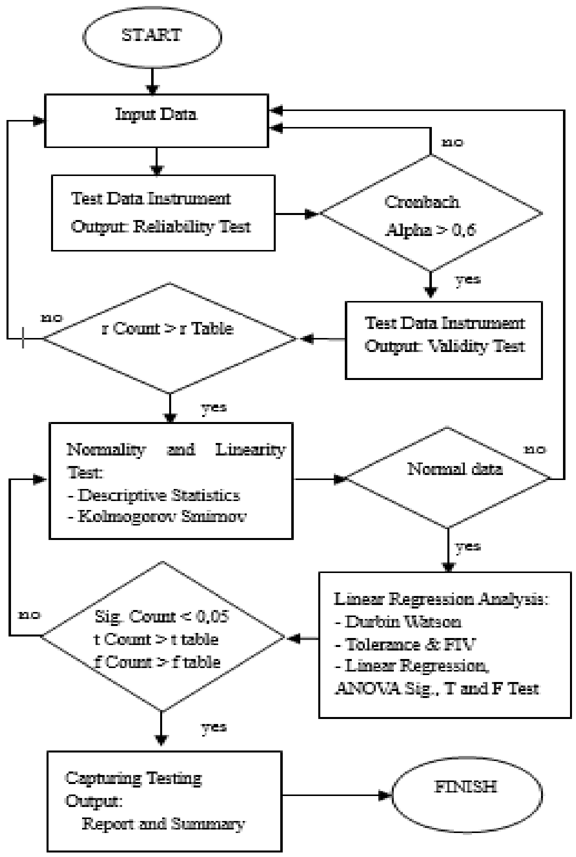

Figure 6. Data processing stage with SPSS [16]

Main Factor

The Main Factor is the main sub-dimension of the variable. The main variables are broken down into smaller sub-dimensions and each main factor has a sub-factor component. In this study, there are five main factors: Lean Six Sigma Variables, Variable Time-cost trade-off, Ammunition Warehouse Work Variables, Variable Cost, and Time Variable. The explanation of the Main Factor is as follow:

- Lean Six Sigma Variables: Define, Measure, Analyse, Process, Improve
- Variable Time cost trade-off: Design Delays and Improvements
- Ammunition Warehouse Work Variables: Team composition and capability and Control Project
- Variable Cost: Cost
- Time Variable: Time

Sub Factor

Sub Factor is a sub-dimensional of the main factor. Sub-factors are questions that the respondent will answer and fill in by giving a score for each item. The distribution of sub-factors for each main factor is as follows:

- Main factor Define consists of five sub factors
- Main factor Measure consists of 4 sub factors
- Main factor Analyse consists of 5 sub factors
- Main Process factor consists of 3 sub factors
- Main factor Improve consists of 3 sub factors
- Main Delay factor consists of 5 sub factors
- Main factor Design Improvement consists of 5 sub factors
- Main factor Team composition and capability consists of 5 sub factors
- Main factor Control Project consists of 5 sub factors
- Main factor Cost consists of 5 sub factors
- Main Time factor consists of 5 sub factors

Table 1 lists the key success factors obtained from the literature study and expert validation.

A minimum number of respondents answered the questionnaire required as limitations in gathering the required results. According to [16], the needs of the respondent can be obtained using (1) and (2).

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

$$n = \frac{m}{1 + \frac{(m-1)}{N}} \quad (2)$$

So, $N = 40$, $\varepsilon = 0{,}05$, $P = 0{,}5$

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

Based on the *p-value*, the Z value is obtained based on the Z table of normal distribution, Z = 1.96. Then the minimum respondent needs are: m = 384.16 and n = 36.31

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 0.2027, it can be declared valid and the value of Cronbach's Alpha (Calculated Reliability). If the value is more than 0.600, it can be stated as realistic. Table 2 and Table 3 show the results of data grouping that are both realistic and valid.

Regression is used to estimate the dependent variable's value from the independent variable's value. To determine the effect of the independent variables in this study, namely Lean Six Sigma (X1), Time Cost Trade Off (X2), and Ammunition Warehouse (X3), on the dependent variable, namely Cost (Y1) and Time (Y2), multiple linear regression was used because the independent variable in this study is more than one variable. The results clearly can be seen from Table 4 and Table 5.

Table 1. Key success factor

No	Variable	Main Factor		Sub Factor	Reference
1	Lean Six Sigma (X1)	Define	X1.1	Cost Reduction	[17]
			X1.2	Elimination or reduction of waste	[17]
No	**Variable**	**Main Factor**		**Sub Factor**	**Reference**
1	Lean Six Sigma (X1)	Define	X1.3	Product Quality	[17]
			X1.4	Productivity	[17]
			X1.5	Flexibility	[17]
		Measure	X1.6	Use of Materials and Storage Systems	[18]
			X1.7	Fewer Design Changes	[18]
			X1.8	Improve Communication Among Project Participants	[18]
			X1.9	Waste Management Regulation	[18]
		Analyse	X1.10	Effectiveness of project leader	[19]
			X1.11	Training and support for users	[19]
			X1.12	Organisational change management	[19]
			X1.13	Use of consultants	[19]
			X1.14	End user involvement	[19]
		Process	X1.15	Supported Operating System	[20]
			X1.16	App Update	[20]
		Improve	X1.17	PC Devices That Support	[20]
			X1.18	Disability Rate Work in Process	[21]
			X1.19	Evaluating Quality	[21]
			X1.20	Variability Reduction	[21]
2	Time Cost Trade Off (X2)	Delay	X2.1	Financial	[22]
			X2.2	Characteristics of the Place	[22]
			X2.3	Inspection Systems, Control	[23]
			X2.4	Job Evaluation	[23]
			X2.5	Contract	[23]
			X2.6	Poor Consultant Communication	[24]
		Design Improvements	X2.7	Knowledge of Design	[24]
			X2.8	The Number of Workers Less	[25]
			X2.9	The Use of Technology is Not Efficient	[25]
			X2.10	Management is Not Good	[25]
3	**Ammunition Warehouse (X3)**	Team Composition and Capability	X3.1	Job-plan execution	[26]
			X3.2	team leader personality	[26]
			X3.3	client input	[26]
			X3.4	workshop plan	[26]
			X3.5	relationships within the design team	[26]
		Control Project	X3.6	control of workshop	[27]
			X3.7	plan for implementation	[27]
			X3.8	personalities of participants	[27]
			X3.9	Client support and active participation	[27]
			X3.10	cooperation from related departments	[27]
4	**Cost (Y1)**	Cost	Y1.1	The relationship between management and labor	[28]
			Y1.2	Preparation and approval drawings delays	[28]
			Y1.3	Planning and scheduling inadequate	[28]
			Y1.4	Poor site management and supervision	[28]
			Y1.5	Error during construction	[28]
5	**Time (Y2)**	Time	Y2.1	Prediction of production rate craftsmen inaccurate	[29]
			Y2.2	Lack of skilled labor	[29]
			Y2.3	Project location restrictions	[29]
			Y2.4	Poor labor productivity	[29]
			Y2.5	Design changes	[29]

Table 2. Results of Test Validity

Variable	Cronbach's Alpha	Comparative Value	Description
Lean Six Sigma	0.372	0.2027	Valid
Time cost trade-off	0.621	0.2027	Valid
Ammunition Warehouse	0.521	0.2027	Valid
Cost	0.555	0.2027	Valid
Time	0.539	0.2027	Valid

Table 3. Results Test Reliability

Variable	Cronbach's Alpha	Comparative Value	Description
Lean Six Sigma	0,722	0,600	Reliable
Time cost trade-off	0,841	0,600	Reliable
Ammunition Warehouse	0,719	0,600	Reliable
Cost	0,707	0,600	Reliable
Time	0,722	0,600	Reliable

Table 4. Recapitulation of Multiple Linear Regression Test Results Model 1

Model		UC B	UC SE	SC Beta	t	Sig
1	(Constant)	2.415	1.146		2.108	0.039
	LCC	0.192	0.024	0.506	8.124	0.000
	TCTO	0.176	0.024	0.331	7.218	0.000
	Ammunition Warehouse	0.156	0.022	0.431	7.109	0.000

Dependent Variable: Cost Perform

$$\widehat{Y_2} = 2.415 + 0.192X_1 + 0.176$$

Y1 = Cost
X1 = Lean Six Sigma
X2 = Time Cost Trade Off
X3 = Ammunition Warehouse
The equation explains that:

The constant value of +2.415 explains that without being influenced by the independent variable (X), namely Lean Six Sigma (X1), Time cost trade off (X2), and Ammunition Warehouse (X3), the value of the dependent variable, namely Cost (Y1) is 2.415 units, it means that without being influenced by the application of the Lean Six Sigma method, the time cost trade off on the ammunition warehouse work will reduce costs by 24.15%.

The value of the Lean Six Sigma regression coefficient (X1) of + 0.192 explains that each addition of one unit of Lean Six Sigma value will increase the cost value by 0.192 units, assuming other variables are held constant. The X1 variable in this study turned out to positively affect cost efficiency (Y). If the implementation of Lean Six Sigma on ammunition warehouse work is done well, the cost efficiency will increase.

The regression coefficient value of Time cost trade-off (X2) of + 0.176 explains that each addition of one unit of Time cost trade-off value will increase the value of Cost by 0.176 units, assuming other variables are held constant. Furthermore, the X2 variable in this study turned out to positively affect cost efficiency (Y). Therefore, if the implementation of the Time-Cost Trade-Off on ammunition warehouse work is carried out properly, the cost efficiency will increase.

Ammunition Warehouse regression coefficient value (X3) of 0.156 explains that each addition of one unit of Ammunition Warehouse value will increase the Time value by 0.156 units, assuming other variables are considered constant. Variable X3 turned out to positively affect cost efficiency (Y). If the application of the Lean Six Sigma and Time-Cost Trade-Off methods on the ammunition warehouse work is carried out properly, the cost efficiency will increase.

Table 5. Recapitulation of Multiple Linear Regression Test Results Model 2

Model		UC B	UC SE	SC Beta	t	Sig
1	(Constant)	2.161	0.911		2.372	0.021
	LCC	0.191	0.019	0.527	10.155	0.000
	TCTO	0.159	0.019	0.313	8.197	0.000
	Ammunition Warehouse	0.150	0.017	0.435	8.602	0.000

a. Dependent Variable: Time Perform

$$\widehat{Y_2} = 2.161 + 0.191X_1 + 0.159X_2 + 0.150X_3$$

Y2 = Time
X1 = Lean Six Sigma
X2 = Time Cost Trade Off
X3 = Ammunition Warehouse
where:
Y – explained variable, β0, β1, β2, …, βk+1 – regression coefficients (structural parameters) of the equation model in the collection, X1, X2, …, Xk+1 – explanatory variables or functions of explanatory variables, E – random factor [30].
The equation explains that:

The constant value of 2.161 explains that without being influenced by the independent variable (X), namely Lean Six Sigma (X1), Time-Cost Trade-Off (X2), and Ammunition Warehouse (X3), the value of the dependent variable, namely Time (Y2) is 2.161 units, meaning that without being influenced by the application of the lean six Sigma method, the Time-cost trade-off at the Ammunition Warehouse will reduce processing time by 21.61%.

The value of the Lean Six Sigma regression coefficient (X1) of 0.191 explains that each addition of one unit of Lean Six Sigma value will increase the value of Time by 0.191 units, assuming other variables are considered constant. Furthermore, the X1 variable in this study positively affected cost efficiency (Y). Therefore, if the application of Lean Six Sigma on ammunition warehouse work is carried out well, time efficiency will increase.

The regression coefficient value of Time-Cost Trade-Off (X2) of 0.159 explains that each addition of one unit of Time cost trade-off value will increase the value of Time by 0.159 units, assuming other variables are considered constant. Furthermore, the X2 variable in this study turned out to positively affect cost efficiency (Y). Therefore, if the Time-Cost Trade-Off on ammunition warehouse work is carried out well, efficiency will be achieved and time increases.

Ammunition Warehouse regression coefficient value (X2) of 0.150 explains that each addition of one unit of Ammunition Warehouse value will increase the Time value by 0.150 units, assuming other variables are considered constant. The X3 variable in this study turned out to positively affect cost efficiency (Y). If Lean Six Sigma and Time-Cost Trade-Off methods on ammunition warehouse work are carried out properly, time efficiency will increase.

Partial Test (t-Test)

The t-test aims to determine whether or not there is a partial effect given by the variable (X), namely Lean Six Sigma (X1), Time cost trade-off (X2), and Ammunition Warehouse (X3). To the variable (Y1), namely Cost, is listed in Table 6. Partial Test (t-Test) on the variable (Y2), namely Time, is listed in Table 8.

The Effect of Variable X Simultaneously on Y1 and Y2 (Test F)

The basis for decision making by comparing f table and f count: The variables X1, X2, X3 have a positive and significant effect on Y1. This is illustrated by sig. (F) 0.000 < 0.05, see Table 7. The basis for decision making by comparing f table and f count: The variables X1, X2, X3 have a positive and significant effect on Y2. This is illustrated by sig. (F) 0.000 < 0.05, see Table 9.

The results of the analysis of this average later compiled into a recapitulation presented in the form of sub-factor ratings, sub ten most influential factors, ten sub least influential factors, the most influential factors play ranked and rank the most influential variables. The results of the recapitulation of statistical analysis using the average method, more details can be seen in Table 10.

Table 6. Recapitulation t-Test Results

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.140	.746		.188	.851
	x1	.149	.014	.425	10.656	.000
	x2	.144	.016	.428	9.242	.000
	x3	.143	.020	.300	7.222	.000

a. Dependent Variable: y1

Table 7. Recapitulation F Test Results

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	321.475	3	107.158	307.600	.000[b]
	Residual	19.509	56	.348		
	Total	340.983	59			

a. Dependent Variable: y1

b. Predictors: (Constant), x3, x1, x2

Table 8. Recapitulation t-Test Results

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.246	1.201		.205	.838
	x1	.133	.023	.393	5.893	.000
	x2	.133	.025	.409	5.291	.000
	x3	.131	.032	.285	4.110	.000

a. Dependent Variable: y2

Table 9. Recapitulation F Test Results

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	265.610	3	88.537	98.037	.000[b]
	Residual	50.573	56	.903		
	Total	316.183	59			

a. Dependent Variable: y2

b. Predictors: (Constant), x3, x1, x2

Table 10. The results of the recapitulation of statistical analysis using the average method

No.	Sub Factors	Valid	Mean	Median	N
1	Planning and scheduling inadequate	65	4.98	5	Valid
2	Job-plan execution	65	4.94	5	Valid
3	Preparation and approval delays pictures	65	4.94	5	Valid
4	Cost Reduction	65	4.88	5	Valid
5	The relationship between management and labor	65	4.86	5	Valid
6	Relationships within the design team	65	4.83	5	Valid
7	Lack of skilled labor	65	4.68	5	Valid
8	Flexibility	65	4.65	5	Valid
9	Errors during construction	65	4.65	5	Valid
10	Prediction production levels craftsmen inaccurate	65	4.65	5	Valid
11	Management and supervision of a bad site	65	4.62	5	Valid
12	Restrictions on the project site	65	4.62	4	Valid
13	Client input	65	4.55	4	Valid
14	Quality of products	65	4.54	4	Valid
15	Financial	65	4.48	4	Valid
16	Design changes	65	4.45	4	Valid
17	Job Evaluation	65	4.42	4	Valid
18	Poor labor productivity	65	4.42	4	Valid
19	Communications Consultants bad	65	4.4	4	Valid
20	The use of technology is not efficient	65	4.35	4	Valid
21	Team leader personality	65	4.35	4	Valid
22	Elimination or reduction of waste	65	4.28	4	Valid
23	Effectiveness of project leader	65	4.23	4	Valid
24	Productivity	65	4.2	4	Valid
25	Characteristics of the place	65	4.06	4	Valid
26	workshop plan	65	4.03	4	Valid
27	Contract	65	4.02	4	Valid
28	Inspection system, control	65	4	4	Valid
29	Use of consultants	65	3.97	4	Valid
30	Design knowledge	65	3.92	4	Valid
31	Client support and active participation	65	3.88	4	Valid
32	control of workshop	65	3.82	4	Valid
33	The number of workers less	65	3.75	4	Valid
34	Management is not good	65	3.75	4	Valid
35	Plan for implementation	65	3.75	4	Valid
36	Training and support for users	65	3.69	4	Valid
37	Personalities of participants	65	3.58	4	Valid

CONCLUSION

This study concludes that after processing the questionnaire with SPSS, the results of the factors that affect the delay in the implementation of the ammunition warehouse by applying the lean six sigma method and time-cost trade-off are as follows: Planning and scheduling inadequate, Job-plan execution, Delay in drawing preparation and approval, Cost reduction, Relationship between management and workforce, Relationships within the design team, Lack of skilled labor, Flexibility, Error during construction, and Inaccurate prediction of craftsman production rate.

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