Analysis of Factor Affecting Labor Productivity in Multy Storey Building Construction Projects in Palu City

Atika[1]; Fahirah F.[2]; Tutang Muhtar Kamaludin[3]

[1]Postgraduate Student of Civil Engineering Department, Tadulako University
[2]Civil Engineering Study Program, Faculty of Engineering, Tadulako University
[3]Civil Engineering Study Program, Faculty of Engineering, Tadulako University

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Abstract: The implementation of a high-rise building construction project in Palu City sometimes encounters several obstacles that occur in the field. These obstacles will usually affect the quality, cost, and time factors that have been planned. One of the influencing factors is worker productivity. The purpose of this study was to determine the factors that influence labor productivity in high-rise building construction projects in Palu City and to determine strategies for increasing labor productivity in high-rise building construction projects in Palu City. The research respondents were 100 people. Data collection techniques were through questionnaire surveys, interviews, and documentation. Data analysis used Pareto diagrams and factor analysis. The results of the analysis show that factors that influence labor productivity in high-rise building construction projects in Palu City are labor wages, discipline and skills factors, construction labor factors, work methods and supervision factors, work equipment factors, work environment conditions factors, and construction material factors. Strategies for increasing labor productivity in high-rise building construction are highly dependent on the implementation of integrated strategies, starting from proper planning and scheduling, periodic monitoring and evaluation, to smooth team coordination. Workforce training and motivation, adequate facilities and equipment, and a conducive work environment also play a crucial role in ensuring a smooth construction process. By simultaneously optimizing all these aspects, construction projects can be completed more efficiently, safely, and on time, resulting in high-quality construction and maximizing the work output of the construction workforce.

Keywords: *Project, Construction, High-Rise Building, Productivity, Labor.*

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I. INTRODUCTION

Currently, the construction of high-rise buildings is increasing and spreading throughout Indonesia, especially in the Palu City area. This indicates that there are many high-rise construction projects underway. High-rise building construction is one of the alternative to address population growth, land scarcity, and ever-increasing land alternative to address population growth, land scarcity, and ever-increasing land prices, especially in large urban areas, so that the construction of high-rise buildings is necessary to meet the needs of the population, both for residential and office space [1]. The implementation of a high-rise building construction project in Palu City sometimes encounters several obstacles that occur in the field. These obstacles will usually affect the quality, cost, and time factors that have been planned. One of the influencing factors is worker productivity. The efficiency of the workforce plays a crucial role in the successful execution of the construction project timetable, as it directly influences how well the construction plan aligns with the actual advancement of work on site. The relationship between the construction schedule and the ongoing construction activities will ultimately have consequences for both the timeframe and the expenses of the project..

The purpose of this study is to determine what factors influence labor productivity, to determine the highest ranking of factors influencing labor productivity, and to determine strategies for increasing labor productivity in high-rise building construction projects in Palu City.

II. LITERATURE REVIEW

➢ *Definition of Construction Project*

A construction project refers to activities related to infrastructure development, typically involving major tasks in the fields of engineering and architecture [2]. Every project in this sector requires various resources to achieve its objectives,

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including labor, budget, equipment, implementation methods, and building materials. The success or failure of a construction project depends largely on how effectively these resources are managed. Project management is essential in any construction activity to ensure that all resources are managed effectively, thus meeting three established constraints [3]: the allocated budget, the time schedule, and quality standards. These three constraints are crucial elements often considered the primary objectives of project implementation [4].

➢ *Construction of Multi-Story Buildings*

A multi-story building is a structure with several levels arranged vertically . This construction is carried out due to the increasingly scarce land in urban areas, coupled with the high cost of housing and the increasing demand for space for various activities. Generally, multi-story buildings are constructed using reinforced concrete structures, because they provide excellent resistance to withstand all the loads within the building [5]. The structure is divided into two parts: the lower and upper parts. One component of the lower structure is the foundation and elements located underground. Meanwhile, the upper structure includes building elements visible above ground level, such as columns, beams, slabs, and stairs. Each element of this structure has a different role but supports each other in the overall building [6]. Therefore, proper structural planning is necessary to meet standards for strength, comfort, safety, and durability.

➢ *Labor Productivity in Construction*

Labor productivity in the construction sector is one of the most important parameters for assessing a project's success [7]. Productivity relates to how efficiently labor, tools, and materials produce specific results within a specified time and cost. Labor productivity in the construction industry can be measured quantitatively and is determined by the ratio of results (work output) to inputs (labor, time, and cost) [8]. In the realm of high-rise building projects, labor productivity is a crucial element due to the dominant role of manual labor and the high level of technical complexity.

➢ *Project Consultant*

A consultant is an individual or entity appointed by a service user who possesses knowledge and experience in developing construction projects [9]. The role of a Project Consultant is crucial to the success of a project. A consulting firm's responsibility is to assist the client during the initial phase of a project (planning and design) to prepare for subsequent steps, as well as during the construction phase (physical implementation of the project).

➢ *Project Contractor*

The contractor has direct responsibility to the project owner and in carrying out his duties is supervised by a supervisory team from the owner and can consult directly with the supervisory team regarding problems that arise during the implementation process [10]. Any changes in the design must be consulted first before work begins. A contractor is a business entity that is bound by a contract or hired to carry out a construction project in accordance with the provisions contained in the contract won from the project owner [11]. In the implementation of a construction project, there are many tasks that must be completed according to the specified time, so the main contractor requires the presence of subcontractors as partners to assist in completing certain tasks so as to reduce the risk of failure.

III. RESEARCH METHODS

➢ *Research Location*

The research locations for several high-rise building construction projects in Palu City are:

- Construction of the Mamboro Logistics Building Retaining Building (2023)
- Physical Construction of the Rehabilitation of the Palu District Attorney's Office Building (2023)
- Physical Construction of the Rehabilitation of the Palu District Attorney's Office Building (2024)
- Purchase of PSC 119 Building Construction Package (PHYSICAL DAK) (2024)
- Talise Community Health Center Building Construction Package Purchase (DAK FISIK) (2024)
- Construction of the Mamboro Logistics Building Retaining Structure (Continued)

➢ *Data Collection Techniques*

The data collection technique in this study uses 2 data management methods, namely:

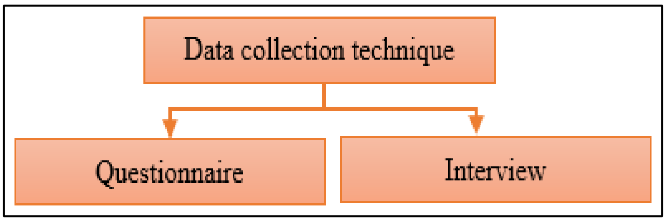

Fig 1 Data Collection Process

➢ *Research Instruments*

There are two primary factors that affect the quality of research findings, which are the quality of the research tools and the data collection process .[12] The instrument used in this study was a questionnaire. The tool utilized for this research was a survey. In quantitative studies, the caliber of the research tool pertains to how valid and reliable it is, while the quality of data collection concerns how accurate the data collection methods are [13]. Instruments in quantitative research include tests, interview guides, observation guides, and questionnaires. A survey is a method of gathering data that requires participants to respond to a series of written queries or statements.[14] The instrument used in this study is intended to produce accurate data, namely by using a Likert scale used to measure the attitudes, opinions, and perceptions of an individual or group of people regarding a social phenomenon. The following is an explanation of the 5-point Likert scale:

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Table 1 Questionnaire Answer Criteria

No.	Assessment criteria	Likert Scale
1.	Strongly disagree	1
2.	I disagree	2
3.	Quite agree	3
4.	Agree	4
5.	Strongly agree	5

➢ *Samples and Sampling Techniques*

The population in this study was all consultants and contractors operating in Palu. Population data was obtained from the database of construction service companies registered with the Construction Services Development Institute (LPJK) and/or relevant government agencies that maintain official data on construction service companies in Palu City.

Table 2 Research Population

		Population
1.	Consultant	62
2.	Contractor	73
	Amount	**135**

The method of sampling applied in this research is known as random sampling, which is a sampling approach that grants every individual within the population the same chance of being chosen as part of the sample.. This technique is used to reduce bias in sample selection so that the sample obtained is more representative of the population. To determine how large the sample size is to represent the population, the researcher used the Slovin formula (1993) guidelines. The Slovin formula used to determine sample size is:

$$n = \frac{N}{1 + Nn^2}$$

Where:

n =Number of samples
N =Population size
e = Limiterror tolerance

According to the Slovin formula, this research involved a sample of 100 individuals. The calculation for the sample size utilizing the Slovin formula is detailed below:

$$n = \frac{N}{1 + Nn^2}$$

$$n = \frac{135}{1 + 135(0{,}05)^2}$$

$$n = 100{,}934 \approx 100$$

In this study, the population used was construction service providers in Palu City. The sample consisted of consultants and contractors randomly selected from within Palu City. The following is a list of respondents and their number.

Table 3 Research Sample

	Population	Sample	Respondents
Consultant	62	42	42
Contractor	73	58	58
Amount	**135**	**100**	**100**

➢ *Data Analysis*

- *Analysis Factor*

Factor analysis is a statistical analysis that aims to reduce the dimensionality of data by expressing the original variables as linear combinations of several factors, so that these factors can optimally explain the diversity of data generated from the original variables. The primary aim of factor analysis is to explain the configuration of connections among different variables represented as factors, unobserved variables, or result variables. The factors identified are intrinsic elements that cannot be observed, quantified, or ascertained directly.

Factor analysis is a technique employed to evaluate the connections among multiple variables at the same time, with the goal of streamlining the associations between the variables being examined into fewer factors than those originally present. In other words, factor analysis functions to group variables that have similarities or similarities into one factor, so that the various attributes that influence a variable component can be filtered into a few key factors with a smaller number. Factor analysis has the following stages:

- ✓ Determine what variables will be analyzed
- ✓ Calculating the correlation matrix using the Bartlett test of sphericity method and the MSA (measure of sampling adequacy) measurement.
- ✓ Extraction or factoring process

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- ✓ Determining the number of factors
- ✓ Rotation of factors
- ✓ Determining factor scores

- *Pareto Diagram*

A Pareto chart is a useful statistical tool for identifying and prioritizing key problems by presenting data in the form of a bar graph sorted from most to least frequent, complete with a cumulative line. This tool is based on the Pareto Principle, or the 80/20 rule, which indicates that the majority of problems (around 80%) are usually influenced by a few key factors (around 20%). The primary function of a Pareto chart is to support the decision-making process by focusing on the most significant causes of problems. Furthermore, this chart is also used to increase the effectiveness of quality improvement by directing resources to the most influential factors. A Pareto chart allows organizations or individuals to visually and systematically identify the root causes of problems. This tool also makes it easier to convey data because the presentation is simple and easy to understand for various groups. One of the advantages of a Pareto chart is its ability to simplify complex data, thus making it clearer to focus on improvements. The steps for creating a Pareto chart are:

- ✓ Identify the Problem or Category
- ✓ Calculate the Frequency of Each Category
- ✓ Sort from Highest to Lowest Frequency
- ✓ Calculate the Percentage of Each Category
- ✓ Calculate Cumulative Percentage
- ✓ Create a Pareto Chart
- ✓ Diagram Analysis

IV. RESULTS AND DISCUSSION

In this research, the investigators chose participants that mirror the features and attributes displayed by the individuals. Following this, we outline the overall attributes of the participants based on their gender, age, educational attainment, and professional experience.

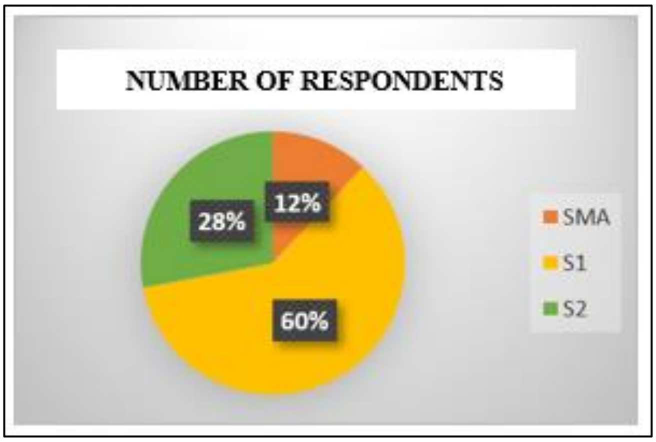

Fig 2 Percentage Diagram of Respondents' Last Education

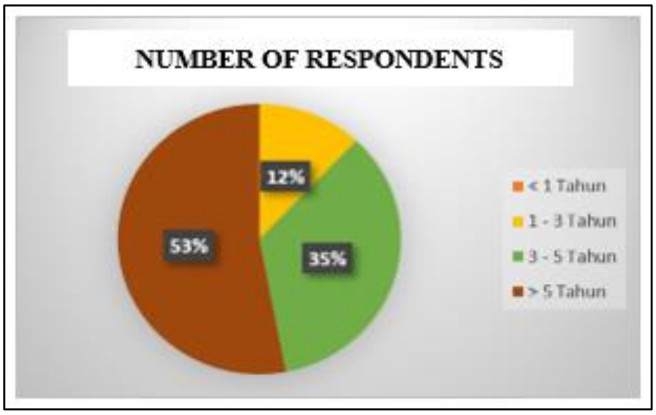

Fig 3 Work Experience Percentage Diagram

- ➢ *Validation Test*

To verify the accuracy of a questionnaire for each variable, it is essential to conduct a validity test. The method applied to assess the validity of the statement items in this research is the Variate Pearson Correlation [15]. This involves correlating each individual indicator score with the overall variable score from the questionnaire. When rhitung exceeds rTable, the instrument is considered valid, whereas if rhitung is less than rTable, the instrument is deemed invalid. Additionally, this can be assessed using a significance level (2-tailed) of less than $\alpha = 0.05$. In the present validity assessment, the researcher evaluated the responses from 50 participants, applying a 95% confidence level or a significance level (α) of 0.05, resulting in an rTable value of 0.195. The conducted validity test in this research is displayed in the subsequent table:

Table 4 Results of Validity Test of Research Variables

Correlations			
	r_{hitung}	r_{tabel}	**Information**
X1.1	.746**	0.195	Valid
X1.2	.755**	0.195	Valid
X1.3	.697**	0.195	Valid
X1.4	.677**	0.195	Valid
X1.5	.729**	0.195	Valid
X1.6	.738**	0.195	Valid
X2.1	.858**	0.195	Valid
X2.2	.873**	0.195	Valid
X2.3	.815**	0.195	Valid

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X2.4	.789**	0.195	Valid
X2.5	.752**	0.195	Valid
X2.6	.763**	0.195	Valid
X3.1	.476**	0.195	Valid
X3.2	.439**	0.195	Valid
X3.3	.457**	0.195	Valid
X3.4	.442**	0.195	Valid
X3.5	.427**	0.195	Valid
X3.6	.412**	0.195	Valid
X4.1	.605**	0.195	Valid
X4.2	.598**	0.195	Valid
X4.3	.611**	0.195	Valid
X4.4	.615**	0.195	Valid
X4.5	.563**	0.195	Valid
X4.6	.587**	0.195	Valid
X5.1	.619**	0.195	Valid
X5.2	.661**	0.195	Valid
X5.3	.658**	0.195	Valid
X5.4	.642**	0.195	Valid
X5.5	.622**	0.195	Valid
X5.6	.639**	0.195	Valid
X6.1	.541**	0.195	Valid
X6.2	.499**	0.195	Valid
X6.3	.532**	0.195	Valid
X6.4	.487**	0.195	Valid
X6.5	.521**	0.195	Valid
X6.6	.526**	0.195	Valid

Based on the findings from the validity test calculations shown in the table above, it is evident that rhitung exceeds r tabel (0.195) for every indicator in the questionnaire, which means all are considered valid. Consequently, the information for each indicator is eligible for further analysis.

➤ *Reliability Test*

Measurements with strong reliability are those that yield consistent data.[16] One common approach for assessing reliability is through Cronbach's Alpha. When the Cronbach's Alpha score exceeds 0.60, it indicates that the variables being tested have dependable indicators. The findings from the reliability assessment concerning the research variables are displayed in the table below:

Table 5 Reliability Test Results

Number of Question Items	**Cronbach's Alpha Value of SPSS Test**	**Cronbach's Alpha Value of Minimum Test**	**Information**
36	0.875	0.600	Very Reliable

The outcomes of the reliability assessment carried out with SPSS software indicate that the Cronbach's Alpha value for the frequency scale related to risk criteria yielded a coefficient of 0.875. Similarly, the risk impact coefficient was also found to be 0.875. Since the lowest acceptable value for the Cronbach's Alpha coefficient is 0.600, the result shown in the table above is considered satisfactory or dependable.

➤ *Factor Analysis Results*

- *KMO (Keiser Meyer Olkin) test and Bartlett's test*

The KMO (Keiser Meyer Olkin) test and Bartlett's test are used to determine whether a variable is suitable for further factor analysis.

Table 6 KMO Test and Bartlett's Test Results (before Release)

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin.		0.642
Bartlett's Test of Sphericity	Approx. Chi-Square	643,546
	df	300
	Sig.	0,000

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According to the information presented in the table above, the results for KMO and Bartlett's Test are 0.642, and the significance level for Bartlett's Test of Sphericity is 0.000. Since the KMO score is greater than 0.5 and Bartlett's significance is less than 0.05, this indicates that the indicator is suitable for further prediction and analysis.

- *MSA Test (Measure of Sampling Adequacy)*

The MSA (Measure of Sampling Adequacy) test is a metric used to evaluate the relationship between variables and the appropriateness of factor analysis. The Anti-Image Matrix is used to identify and select appropriate variables for factor analysis.

Table 7 MSA Test Results before Issuance

Sub Factors	MSA Value	Criteria	Information
X1.1	0.792	> 0.50	MSA Eligibility
X1.2	0.878	> 0.50	MSA Eligibility
X1.3	0.761	> 0.50	MSA Eligibility
X1.4	0.778	> 0.50	MSA Eligibility
X1.5	0.717	> 0.50	MSA Eligibility
X1.6	0.781	> 0.50	MSA Eligibility
X2.1	0.819	> 0.50	MSA Eligibility
X2.2	0.861	> 0.50	MSA Eligibility
X2.3	0.783	> 0.50	MSA Eligibility
X2.4	0.752	> 0.50	MSA Eligibility
X2.5	0.708	> 0.50	MSA Eligibility
X2.6	0.721	> 0.50	MSA Eligibility
X3.1	0.767	> 0.50	MSA Eligibility
X3.2	0.732	> 0.50	MSA Eligibility
X3.3	0.658	> 0.50	MSA Eligibility
X3.4	0.422	> 0.50	Not MSA Eligible
X3.5	0.474	> 0.50	Not MSA Eligible
X3.6	0.653	> 0.50	MSA Eligibility
X4.1	0.615	> 0.50	MSA Eligibility
X4.2	0.596	> 0.50	MSA Eligibility
X4.3	0.672	> 0.50	MSA Eligibility
X4.4	0.704	> 0.50	MSA Eligibility
X4.5	0.461	> 0.50	Not MSA Eligible
X4.6	0.432	> 0.50	Not MSA Eligible
X5.1	0.523	> 0.50	MSA Eligibility
X5.2	0.691	> 0.50	MSA Eligibility
X5.3	0.604	> 0.50	MSA Eligibility
X5.4	0.543	> 0.50	MSA Eligibility
X5.5	0.375	> 0.50	Not MSA Eligible
X5.6	0.768	> 0.50	MSA Eligibility
X6.1	0.768	> 0.50	MSA Eligibility
X6.2	0.622	> 0.50	MSA Eligibility
X6.3	0.497	> 0.50	Not MSA Eligible
X6.4	0.395	> 0.50	Not MSA Eligible
X6.5	0.671	> 0.50	MSA Eligibility
X6.6	0.743	> 0.50	MSA Eligibility

It can be seen in the table above the results of the MSA test analysis, namely the diagonal value of the Anti-Image Matrices, it is known that there are several indicators studied that have a value <0.5, so the researcher needs to remove the sub-factor items and carry out retesting.

Table 8 KMO Test Results and Bartlett's Test after Release

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin.		0.755
Bartlett's Test of Sphericity	Approx. Chi-Square	516,059
	df	210
	Sig.	0,000

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According to the table presented, the results for the KMO and Bartlett's Test are 0.755, while the Bartlett's Test of Sphericity is 516.509 with a significance level of 0.000. Since the KMO value exceeds 0.5 and the significance of Bartlett's is less than 0.05, it indicates that the indicator is suitable for prediction and further analysis. Therefore, the data for this research is regarded as acceptable, allowing for the continuation of data analysis to the phase of re-evaluating the MSA value for the other variables.

Table 9 MSA Test Results after Issuance

Sub Factors	**MSA Value**	**Criteria**	**Information**
X1.1	0.787	> 0.50	MSA Eligibility
X1.2	0.769	> 0.50	MSA Eligibility
X1.3	0.753	> 0.50	MSA Eligibility
X1.4	0.684	> 0.50	MSA Eligibility
X1.5	0.782	> 0.50	MSA Eligibility
X1.6	0.793	> 0.50	MSA Eligibility
X2.1	0.857	> 0.50	MSA Eligibility
X2.2	0.863	> 0.50	MSA Eligibility
X2.3	0.845	> 0.50	MSA Eligibility
X2.4	0.747	> 0.50	MSA Eligibility
X2.5	0.691	> 0.50	MSA Eligibility
X2.6	0.687	> 0.50	MSA Eligibility
X3.1	0.725	> 0.50	MSA Eligibility
X3.2	0.622	> 0.50	MSA Eligibility
X3.3	0.591	> 0.50	MSA Eligibility
X3.6	0.577	> 0.50	MSA Eligibility
X4.1	0.635	> 0.50	MSA Eligibility
X4.2	0.594	> 0.50	MSA Eligibility
X4.3	0.719	> 0.50	MSA Eligibility
X4.4	0.721	> 0.50	MSA Eligibility
X5.1	0.733	> 0.50	MSA Eligibility
X5.2	0.758	> 0.50	MSA Eligibility
X5.3	0.738	> 0.50	MSA Eligibility
X5.4	0.673	> 0.50	MSA Eligibility
X5.6	0.626	> 0.50	MSA Eligibility
X6.1	0.727	> 0.50	MSA Eligibility
X6.2	0.583	> 0.50	MSA Eligibility
X6.5	0.631	> 0.50	MSA Eligibility
X6.6	0.664	> 0.50	MSA Eligibility

It is evident from the table provided that the findings from the MSA test evaluation, specifically the diagonal values of the Anti-Image Matrices, indicate that every indicator examined has a value greater than 0.5. This suggests that the outcomes of this evaluation are satisfactory, allowing for the subsequent step of factor analysis to proceed.

- *Communality Estimation*

Table 10 Communalities Analysis Results

Communalities		
	Initial	Extraction
X1.1	1,000	0.774
X1.2	1,000	0.806
X1.3	1,000	0.613
X1.4	1,000	0.566
X1.5	1,000	0.726
X1.6	1,000	0.764
X2.1	1,000	0.765
X2.2	1,000	0.832
X2.3	1,000	0.743

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X2.4	1,000	0.731
X2.5	1,000	0.695
X2.6	1,000	0.723
X3.1	1,000	0.593
X3.2	1,000	0.552
X3.3	1,000	0.561
X3.6	1,000	0.513
X4.1	1,000	0.589
X4.2	1,000	0.582
X4.3	1,000	0.642
X4.4	1,000	0.689
X5.1	1,000	0.622
X5.2	1,000	0.748
X5.3	1,000	0.729
X5.4	1,000	0.647
X5.6	1,000	0.653
X6.1	1,000	0.622
X6.2	1,000	0.543
X6.5	1,000	0.550
X6.6	1,000	0.611

The chart presented earlier outlines the numerical values of the variables examined regarding their ability to provide explanations. A variable is deemed effective in elucidating factors if its extraction value surpasses 0.50. According to the findings, each variable's extraction value exceeded 0.50. Hence, it can be inferred that all variables are suitable for factor explanation, allowing for additional analysis to continue.

- *Factor Extracted*

Table 11 Factor Extraction Results

Total Variance Explained								
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Sq	
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance
1	10,248	34,160	34,160	10,248	34,160	34,160	6,356	21,186
2	3,699	12,328	46,489	3,699	12,328	46,489	3,868	12,894
3	3,137	10,458	56,947	3,137	10,458	56,947	3,387	11,289
4	1,879	6,264	63,211	1,879	6,264	63,211	2,575	8,583
5	1,504	5,013	68,224	1,504	5,013	68,224	2,338	7,793
6	1,235	4,117	72,342	1,235	4,117	72,342	2,030	6,766
7	1,135	3,784	76,126	1,135	3,784	76,126	1,961	6,538
8	1,052	3,508	79,634					
9	0.658	2.532	81.315					
10	0.631	2.426	82.150					
11	0,678	3,228	82,159					
12	0,971	3,238	82,872					
13	0.644	2.476	83.790					
14	0,614	2,926	85,085					
15	0,804	2,679	85,551					
16	0.607	2.336	86.126					
17	0.583	2.241	86.784					
18	0,688	2,292	87,843					
19	0,657	2,189	90,033					
20	0,574	1,913	91,946					
21	0,428	1,426	93,371					
22	0,397	1,324	94,695					
23	0,363	1,210	95,905					
24	0,322	1,074	96,980					
25	0,268	0,894	97,874					
26	0,236	0,788	98,662					
27	0,159	0,530	99,192					
28	0,145	0,483	99,675					
29	0,097	0,325	100,000					

The table displayed above illustrates the worth of every variable examined, indicating that there are 7 key factors derived from the analysis of 29 sub-factors. Among these 7 factors, each possesses a factor eigenvalue exceeding 1. The eigenvalue signifies the comparative significance of each factor when assessing the variance of the 29 analyzed sub-factors. To ascertain the impact of the 7 sub-factors, accumulate the variance values in the following manner:

$$21.186\% + 12.894\% + 11.289\% + 8.583\% + 7.793\% + 6.766\% + 6.538\% = 75.050\%$$

Another approach to visualize the count of newly created factors can be done using a scree plot, which displays the eigenvalues relative to the quantity of extracted factors. A peak in this plot, where the slope becomes steep, denotes the emergence of new factors. On the other hand, a gradual slope suggests the absence of new factors being formed. The extraction of factors for this research is illustrated in the upcoming scree plot:

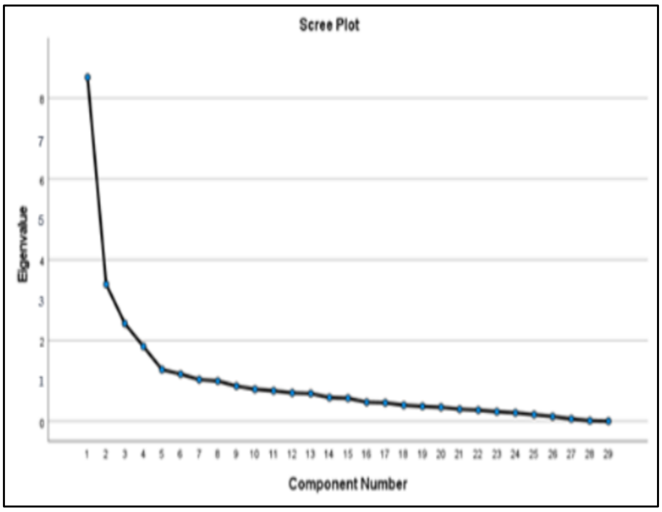

Fig 4 Scree Plot

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Graphically, the Scree Plot illustration indicates the quantity of factors that will be generated (Initial Eigenvalues greater than 1.00). There are 7 component values that exceed 1, thus demonstrating that 7 new factors will be created.

- *Matrix Components and Rotations*

The Component Matrix below, which explains the distribution of each sub-factor that has been analyzed in the 7 newly formed factors.

Table 12 Rotated Component Matrix

Rotated Component Matrix[a]							
	Component						
	1	2	3	4	5	6	7
X1.1	0,034	0,805	0.343	0,045	-0,301	0.051	0,466
X1.2	-0,049	0,763	0.412	-0,014	-0,450	0.320	0,016
X1.3	0,028	0,749	0.034	-0,372	-0,152	0.227	-0,089
X1.4	0,110	0,138	0,695	-0,210	0,261	-0.091	0,140
X1.5	0.390	-0,044	0.051	0,077	-0,156	0,784	-0,026
X1.6	0.142	-0,061	0,677	0,006	-0,162	0,112	-0,159
X2.1	0,841	-0,178	0.129	-0,079	0,236	0,193	-0,028
X2.2	0,846	0,073	0.190	0,213	-0,024	-0,030	0,016
X2.3	0.016	0,210	0,757	0,230	-0,049	-0,105	-0,046
X2.4	0,819	0,066	0.143	0,260	0,356	-0,082	0.383
X2.5	-0.113	-0,122	0,646	-0,093	0,242	0.013	-0.307
X2.6	0.442	-0,098	0,785	0,183	0,439	0.205	0.385
X3.1	0.088	0,266	0,187	-0,089	0.218	0.013	0,680
X3.2	0.295	0,306	-0,039	0.112	0.525	0.003	0,652
X3.3	0.153	-0,256	0,006	-0.016	0.173	0.186	0,665
X3.6	0.349	0,073	0,213	0.464	0.373	0.088	0,613
X4.1	0.073	0.043	-0,136	0.205	0,604	0.202	0.437
X4.2	-0.042	0.047	-0,137	0.082	0,532	0.071	0.112
X4.3	0.169	-0.086	-0.105	0.137	0,768	0.170	0.158
X4.4	0.202	0,580	0.170	0.185	-0.008	-0.079	0.042
X5.1	0.282	0.212	0.225	0,575	-0.050	-0.007	0.017
X5.2	0.020	0.121	0.041	0,757	0.088	0.100	0.077
X5.3	0.095	0.206	0.009	0,731	0.029	0.228	0.002
X5.4	0.268	0.535	-0.099	0.617	0.171	-0.410	0.217
X5.6	-0.065	0.223	0.202	0.712	0.048	-0.196	0.301
X6.1	0.429	0.080	0.234	0.024	0.214	0,757	0.244
X6.2	-0.137	0.196	0.200	-0.044	0.010	0,691	-0.094
X6.5	0.230	0.114	-0.076	0.177	0.149	0,588	0.202
X6.6	-0.008	0.113	0.066	-0.014	0.239	0,680	0.063

The rotated component matrix table's factor analysis results reveal that every variable has a loading factor value higher than 0.3, indicating that every component has an impact on labor productivity in Palu City's high-rise construction projects.

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Table 13 Factor Interpretation Results

No.	Symbol	Sub Factors	Factor
1.	X2.1	Wages given are in accordance with the workload of the workforce.	Factor Work Wages
	X2.2	Payment of wages is made on time.	
	X2.4	The wages received can meet the living needs of the workforce.	
2.	X1.1	The workforce has skills that are appropriate to their field of work.	Discipline and Skill Factors
	X1.2	The workforce has sufficient work experience in construction projects.	
	X1.3	The time discipline of the workforce in attendance and completion of tasks is very good.	
	X4.4	The tool operator has adequate skills.	
3.	X1.4	High work motivation of the workforce in completing work on time.	Factor Construction Workforce
	X1.6	Workers understand work instructions clearly from field supervisors.	
	X2.3	There are incentives or bonuses for good performance.	
	X2.5	There are no delays or deductions from wages without clear reasons.	
	X2.6	The company's financial policies support the welfare of the workforce.	
4.	X5.1	The working methods used are easy for the workforce to understand.	Factor Work Methods and Supervision
	X5.2	The sequence of work execution is arranged efficiently.	
	X5.3	The field supervisor provides clear work instructions.	
	X5.4	Implementation of work follows standard work procedures (SOP).	
	X5.6	Evaluation of work methods is carried out periodically for improvement.	
5.	X4.1	Work tools are available in sufficient quantities for project needs.	Factor Work equipment
	X4.2	The condition of the equipment is always maintained and ready to use.	
	X4.3	It is not uncommon for equipment failure to hinder work.	
6.	X1.5	Communication and cooperation between workers is running well.	Factor Working Environment Conditions
	X6.1	Weather and environmental conditions support smooth work.	
	X6.2	The work area is clean, safe and well organized.	
	X6.5	Work facilities such as rest areas and toilets are adequate.	
	X6.6	The work environment supports the focus and comfort of the workforce.	
7.	X3.1	Materials are always available according to needs in the field.	Factor Construction Materials
	X3.2	The quality of the materials complies with project standards and specifications.	
	X3.3	Delivery of materials to the project site is rarely delayed.	
	X3.6	There was no disruption to work due to lack of materials.	

➢ *Pareto Diagram Analysis Results*

- *Collect Data and Sort the Data According to the Largest Frequency to the Smallest Frequency*

Table 14 Results from Highest Frequency to Lowest Frequency

No.	Strategies for Increasing Labor Productivity	Frequency
1	Proper Planning and Scheduling	88
2	Periodic Monitoring and Evaluation	73
3	Smooth Team Coordination	68
4	Workforce Training and Motivation	63
5	Adequate Facilities and Equipment	42
6	Conducive Work Environment	31
Total		**365**

- *Calculating Percentage and Cumulative Percentage of Data*

Table 15 Results of Percentage Calculation and Compulsory Percentage of Data

No.	Strategies for Increasing Labor Productivity	Frequency	Presentation	Cumulative Percentage
1	Proper Planning and Scheduling	88	24%	24%
2	Periodic Monitoring and Evaluation	73	20%	44%
3	Smooth Team Coordination	68	19%	63%

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4	Workforce Training and Motivation	63	17%	80%
5	Adequate Facilities and Equipment	42	12%	92%
6	Conducive Work Environment	31	8%	100%
Total		365	100%	

* *Make a Diagram of the Percentages Obtained*

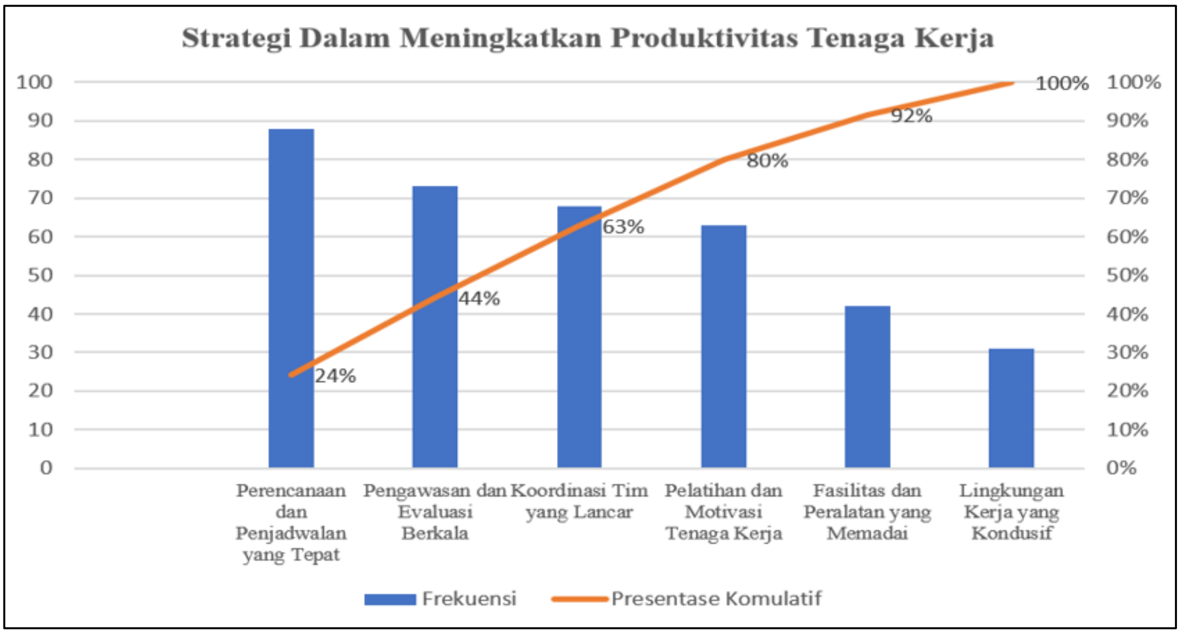

Fig 5 Presentation Diagram of Strategies in Increasing Labor Productivity

The data obtained and analysis above show the blue bars, which represent the frequency (number of incidents/problem units) of each factor, and the orange line, which represents the cumulative percentage contribution of each strategy to increasing workforce productivity. The following is an explanation of these strategies.

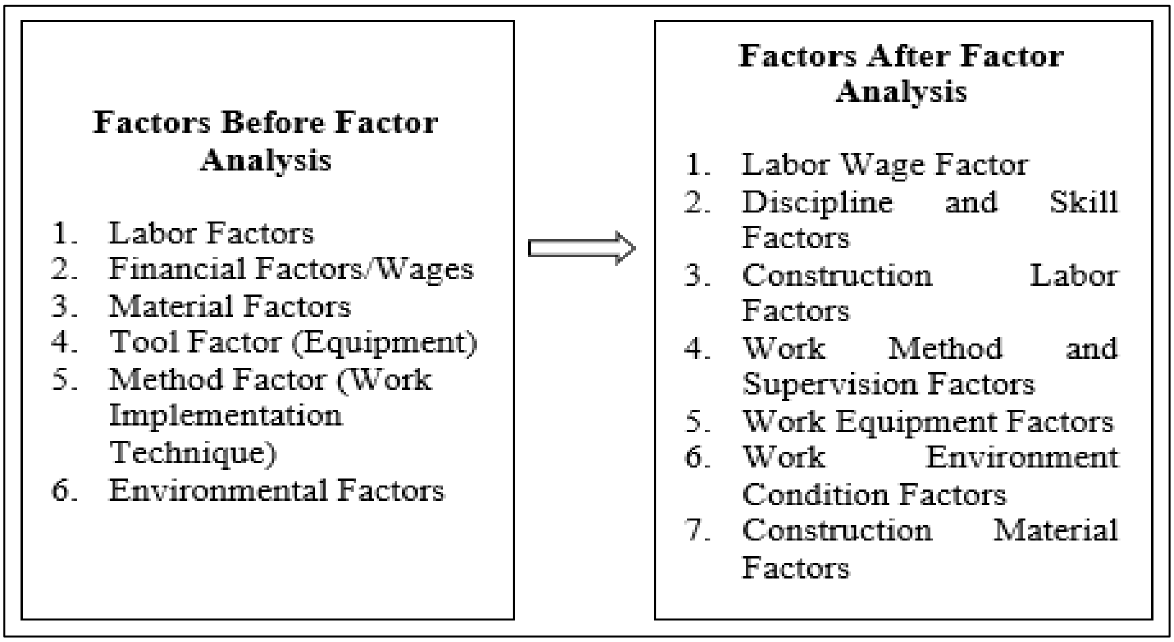

Fig 6 Number of Factors before and after Factor Analysis

Following the KMO/MSA test, only 29 (twenty-nine) variables/statements met the criteria to be included in the factor analysis, out of the original 36 (thirty-six) variables/statements in the questionnaire. The components remained seven factors in this study, but their names differed according to the sub-factor groupings, which were consistent with the factor analysis study.

V. CONCLUSION

Factors that influence labor productivity in high-rise building construction projects in Palu City are labor wages, discipline and skills, construction labor factors, work methods and supervision, work equipment, work environment conditions, and construction material factors. The highest ranking or most dominant factors that influence labor productivity in high-rise building construction projects in Palu City are: first place is the labor wage factor, second place is the discipline and skills factor, third place is the construction labor factor, fourth place is the work methods and supervision factor, fifth place is the work equipment factor, sixth place is the work environment conditions factor, seventh place is the construction material factor. The strategy for increasing labor productivity in high-rise building construction is highly dependent on the implementation of an integrated strategy, starting from proper planning and scheduling, periodic supervision and evaluation, to smooth team coordination. Training and motivation of the workforce, the availability of adequate facilities and equipment, and a conducive work environment also play an important role in supporting the smooth construction process. By optimizing all these aspects simultaneously, construction projects can run more efficiently, safely, and on time, thus producing good building quality and maximizing the work results of construction workers.

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