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Project Performance Improvement through Planning, Technical Factors, Implementation, and Control Case Studies in MEP Contractor Projects

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Abstract— This research was conducted at a firm that operates in the MEP (mechanical, electrical, and plumbing) industry and engages in project management. In practise, the budget for the 2020–2022 project was exceeded, and the late delivery of project supplies resulted in project completion times that beyond the original timeline. This study aims to determine the magnitude of the impact of project planning on technical factors, project implementation, and control, as well as the impact of technical characteristics, project implementation, and management on the performance of MEP (mechanical, electrical, and plumbing) projects. One hundred respondents filled out the questionnaire that yielded the research data. The method of data analysis employed is PLS-SEM 3. The results of this study indicate that project planning effects technical aspects by 66.3%, implementation by 72.2%, and control by 59.0%. For MEP (mechanical, electrical, and plumbing) projects, technological factors have a positive and significant effect on project performance by 31.6%, implementation has a positive and significant effect on project performance by 27%, and control has a positive and significant effect on project performance by 37.4%.

Keywords— planning, implementation, control, project performance, PLS-SEM.

I. INTRODUCTION

List of the projects that MEP Contractors worked on between 2020 and 2022.

Table 1: *List of the projects that MEP Contractors*

YEAR	TYPE	PROJECT	STATUS
2022	Data Center	BNDC - BCA NEW DATA CENTER	On Go
2022	Factory	HM Sampoerna - karawang	On Go
2021	Universitas	Monash university	Finish
2021	Apartemen	Southgate Apartemen 3	On Go
2021	Office	Aerium	Finish
2020	Office	One Tower OCBC - BSD	Finish
2020	Office	Thamrin Nine Tower 2	On Go
2020	Mall / Retail	B Work Aeon Southgate	Finish
2020	Hotel	Manado Eco Resort	On Go

The author lumped together similar-sized initiatives with comparable risks and challenges. Then, we are given projects to evaluate. Project performance is a for MEP contractors.

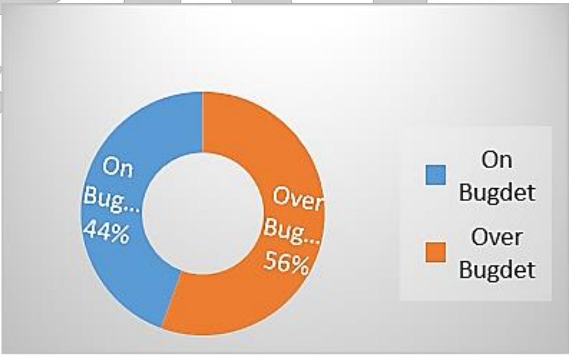

Figure 1: *Project performance graph in terms of costs for 2020 – 2022 at ME Contractors, Source: MEP Project Report, Data processed (2022)*

From the project data observed beginning in 2020–2022, it was determined that 56% of the implemented projects were over budget, while 44% were under budget. Therefore, improvement is required when implementing a project. Material is one of the main components that must be observed because it has a significant impact on the productivity and cost of the project.

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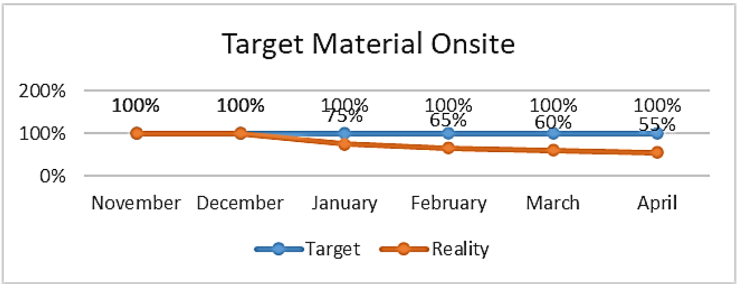

Figure 2: Graph of Material Delay, ***Source:*** *Data on the MEP Contractor Project*

Figure 2 shows that from January to April, there was a delay in materials that helped with parts of the growing MEP contractor project.

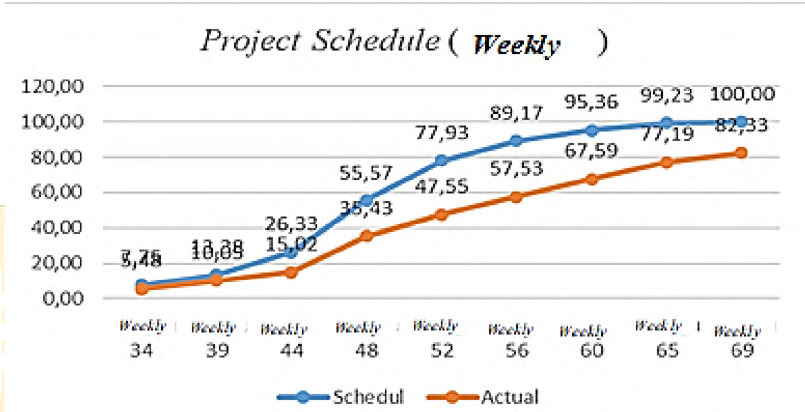

Figure 3: *Graph of Time Target Delays*, ***Source:*** *MEP Contractor Project Data*

To increase the quality of services offered by methodical planning so that resources are utilised more efficiently, hence impacting project performance throughout the organisation. Without proper project management, the company's ability to meet the owner's requirements may be compromised.

Research purpose

What will be accomplished by this study are as follows:

- Understanding how and to what extent project planning impacts MEP contractors' technical factors.
- Knowing the scope and direction of project planning affects the work of MEP contractors.
- Understanding how and to what extent project planning impacts MEP contractor management
- Determining the magnitude of the implementation's impact on the MEP contractor's project performance requires knowledge of how technical factors influence the performance of the MEP contractor's PT on a project.
- Understanding the magnitude of project control's impact on MEP contractor project performance
- Understanding how project planning affects the way MEP contractors do their duties.

II. PROCEDURE FOR PAPER SUBMISSION

A. Project management

Project management is the science and art of leading and coordinating resources consisting of people and materials using modern management techniques to achieve predetermined objectives, including scope, quality, schedule, and budget, and to satisfy the desires of the stakeholder groups.

B. Project Performance

Project Potential According to (Cland, 1995), performance standards are required to implement regulatory actions on the usage of a project's resources. This is so existing resources can be utilised efficiently and successfully in project implementation.

C. Planning

The project scope is significant because it has a direct relationship with the cost and duration of the project's execution, as described in the section on project scope management. It describes the procedures required to ensure that the project includes all professions and activities necessary for its successful management. According to PMBoK 6th Edition, the following are the primary activities .

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D. Technical Factors

Technical project management ability (Technical project management) is defined as the skill to effectively apply project management knowledge to achieve the desired project outcomes. In order to complete the MEP project, a business employs technology. Technology encompasses all the instruments utilised by SDM in MEP installations. If one of these dimensions does not have a positive proportion, the project is more likely to encounter issues, such as delays or costs that exceed the initial budget.

E. Implementation

In order to minimise negative impacts throughout the project's duration, it is necessary to consider a number of factors, such as risks that may occur at each stage at all times and the influence of stakeholders over time, when implementing the project. In contrast, as time and project phases increase, the costs associated with each change will increase at the end of each project phase. Identification of the issue as soon as possible is optimal.

F. Control

Projects with an established change management system Everything is subject to change based on the project's initial conditions and goals. Managing changes, determining which ones can be made and which ones cannot, and understanding how the workflow process operates are crucial. To accommodate the desires and expectations of stakeholders or customers, modifications are made. However, they must still adhere to the commitments made at the outset of the project because it is being carried out with clearly defined objectives and boundaries.

G. Conceptual framework

Following is a description of the conceptual framework model that describes this research problem:

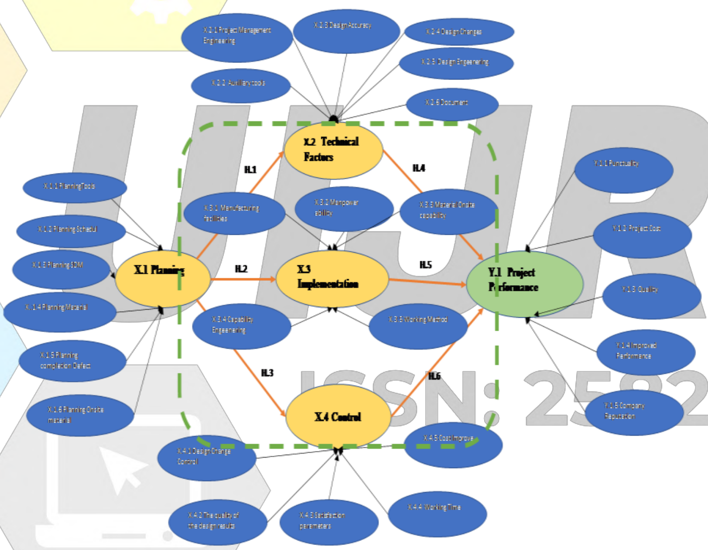

Figure 4: *Basic Framework,* ***Source:*** *Developed Research (2022)*

- First Hypothesis (H1) Project planning affects the technical aspects of the project.
- Second Hypothesis (H2): project planning has an impact on project execution.
- Third Hypothesis (H3): Project planning includes project management.
- Four (H4): Technical Project Factors Influencing Project Performance
- Fifth (H5) Hypothesis: Project Implementation Influences Project Performance
- Sixth Hypothesis (H6): Project Control Influences Project Efficiency.

III. MATH

This research is quantitative and establishes a causal relationship between variables through hypothesis testing, i.e., testing hypotheses based on previously formulated theories; the data obtained is then analysed quantitatively. Minimum sample size is 10 times the indicator for the variable with the greatest number of indicators. Because this study utilised the Smart PLS application, which does not have a sample size limitation, the researchers determined that 100 respondents would serve as examples.

Definition and Operation of Variables

According to Sugiyono (2014), "operational meaning" is the determination of the construct or trait to be studied in order for it to become a measurable variable. The operational definition describes the specific method used to research and operate the construct, allowing other researchers to replicate measurements using comparable methods or develop improved construct measurement techniques.

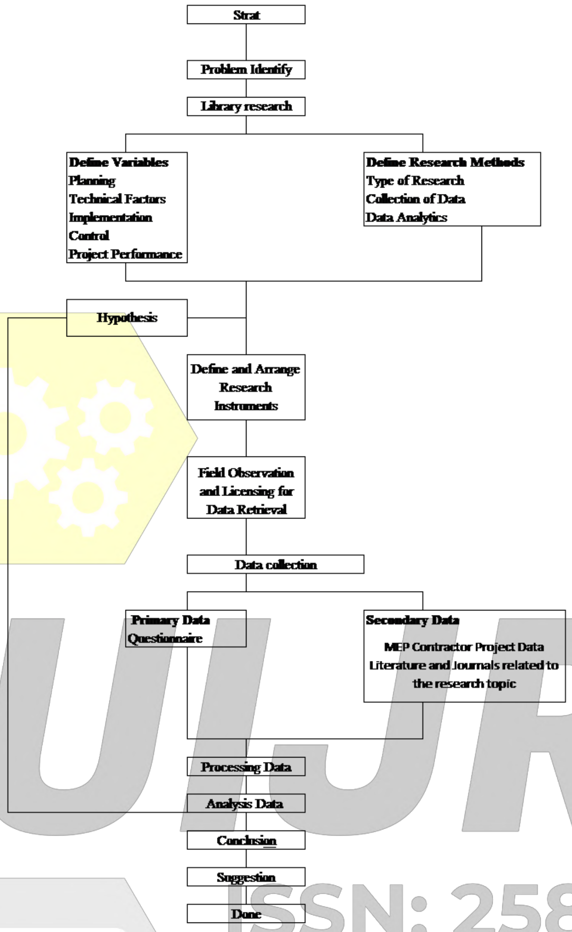

Figure 5: *Basic Framework,* ***Source:*** *processed data (2022)*

Depending on the relationship between two variables, variables can be further classified into two categories:

- The independent variables (so named because they have an impact) This study's independent variables are project planning, MEP project technical aspects, project execution, and project management.
- The dependent variable Project execution The MEP project is the dependent variable that is affected by the independent factors or becomes their impact. This section describes and explains every research variable and its corresponding indicators.

Project planning (X1)

Without proper planning, subsequent project activities such as implementation, management, completion, and maintenance cannot be established. These are the dimensions of this aspect:

- Planning Tools (X1.1) Planning Tools MEP is a tool for monitoring the progress of a project as it is being developed.
- The project schedule planning indicator (X1.2) serves as a baseline for project planning. Realistic, comprehensive, and precise project schedule planning generates a high level of dependability to minimise cost overruns and schedule delays. Muute, N.C. (2019).
- The project cost planning indicator (X1.3) is a benchmark for project planning. A high level of dependability is produced by detailed and accurate cost planning in order to minimise long-term costs. Muute, N.C. (2019).
- The planning for quality assurance (X1.4) acts as a guideline for project planning. Here, quality

planning will aid in producing a successful project outcome. Muute, N.C. (2019).

- Planning for Goal Accomplishment
- Time Defect (X.1.5) is a measure of project planning, with good planning contributing to the production of high-quality results.
- Uute, N.C. (2019).
- On-Stage Material Planning (X.1.6) is an indicator that serves as a benchmark for project planning, where high-quality planning contributes to the delivery of high-quality project results. Muute, N.C. (2019).

Project Technical Factors (X2)

- Engineering and Project Management (X.2.1): Selecting an appropriate model based on the demands of MEP Project users, the project type, and the hazards involved.
- MEP Project techniques and equipment (X.2.2): The selection of an appropriate model is based on the needs of MEP Project users, the nature of the project, and the risks involved.
- Timely shop drawing design (X.2.3): Selecting an appropriate model based on the needs of MEP Project users, the nature of the project, and the associated risks.
- Modifications to the shop drawing design (X.2)
- A suitable model is chosen based on the MEP project's requirements, users, project type, and associated hazards.
- Detailed Engineering Design (X.2.5): A model is chosen based on the needs of MEP project users, the nature of the project, and any associated hazards.
- Clear and detailed documentation and design (X.2.6) and the selection of an appropriate model based on the demands of MEP Project users, the kind of project, and any associated hazards. MEP, users, type of project and associated risks.

Project execution (X3)

- Fabrication (X3.1) is an indicator that serves as a benchmark for undertaking a project. According to SOP and quality standards, the manufacturing procedure contributes to project performance.
- Human resource capability (X3.2) is a metric that serves as a benchmark for project execution.
- Material acquisition (X3.3) is a metric that serves as a benchmark for project execution.
- Engineering Capability (X3.4) is a benchmark for project execution.
- Work Method (X.3.5) is an indicator that serves as a benchmark for undertaking a project. According to SOP and quality standards, the manufacturing procedure contributes to project performance.

Control (X4)

- Change system management (X.4.1) is a metric that drives the measurement of project management and control. On this indication, any specified changes that have an impact on expenses, project schedules, quality, and client satisfaction must be controlled so as not to exceed the baseline. 2017 PMBOK 6th Edition
- Quality of design outcomes (X4.2) is a benchmark indicator for project monitoring and control that focuses on the project scope. Uncontrolled changes in the area will have an influence on costs, project schedules, quality, and customer satisfaction; therefore, they must be managed to remain within the baseline.
- Cost control (X4.3) is an indicator used as a benchmark for project monitoring and control, with a particular emphasis on the project funding monitoring and control process. All expenditures incurred in the project must remain within the budget that was established at the outset; any deviation will have an effect on prices, the project schedule, quality, and customer satisfaction, and must be managed so as not to exceed the established baseline.
- Project schedule control (X4.4) is a 2017 PMBOK 6th Edition indicator used as a benchmark for project monitoring and management. The project schedule is centred on the monitoring and control of this indicator's processes. All actions inside the project must adhere to the initial strategy. Other unforeseen elements that effect prices, project schedules, quality, and customer satisfaction must be accommodated within a set baseline.
- Cost improvement (X4.5) is an indicator used as a benchmark for project monitoring and management in the 2017 PMBOK 6th Edition. The monitoring and control procedure for this indicator focuses on the project timetable. All actions inside the project must adhere to the initial strategy. Other unforeseen elements that effect prices, project schedules, quality, and customer satisfaction must be accommodated within a set baseline. 2017 Sixth Edition PMBOK.

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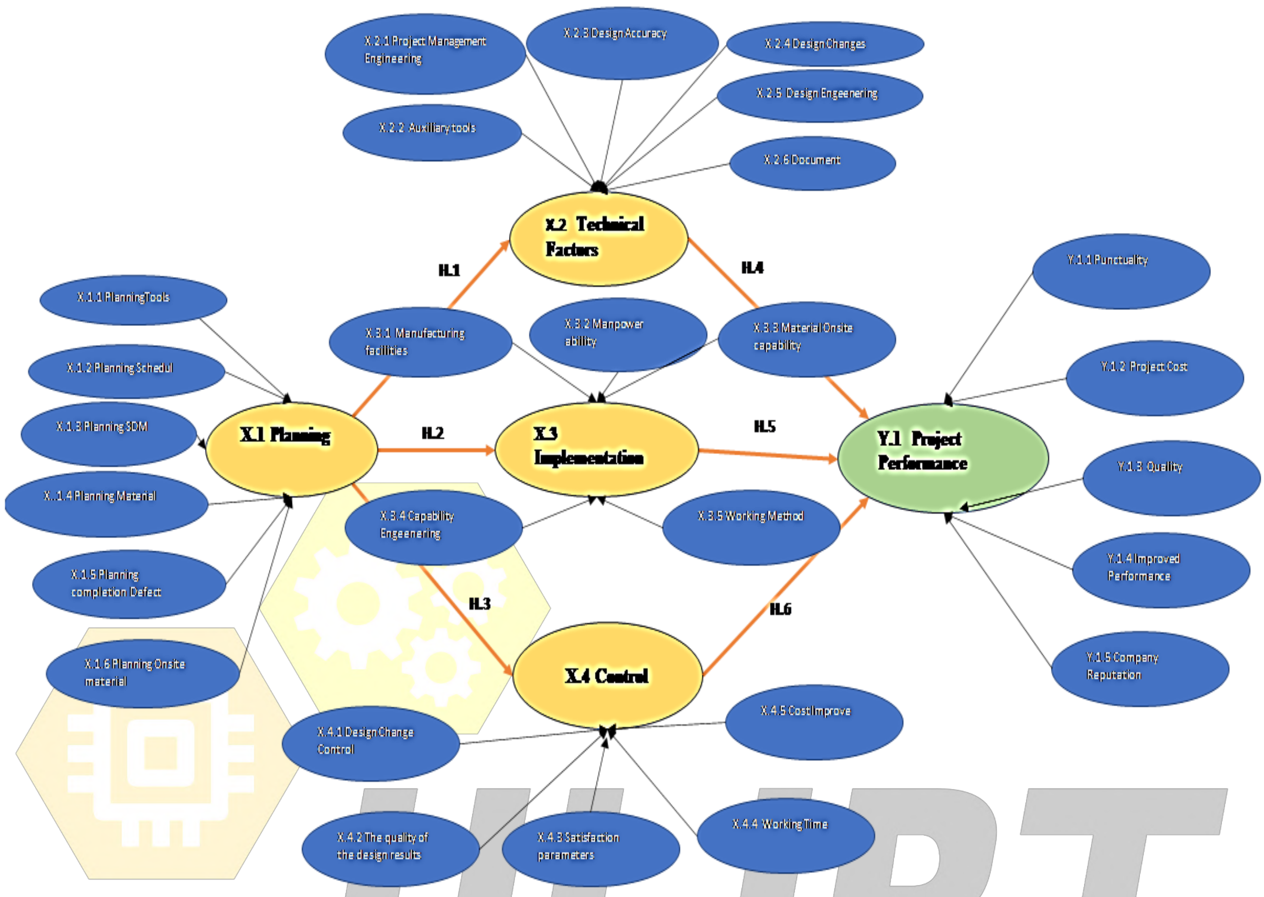

Figure 6: *Variable Relations with Dimensions*

Table 2: *Variable Measurement Model Equation*

Variable	Indicator Weight	Measurement Model Equation
	λPER1.1	X1.1 = λIPER1.1 X1 + δ1
	λPER1.2	X1.1 = λIPER1.2 X1 + δ2
X.1 Project Planning	λPER1.3	X1.1 = λIPER1.3 X1 + δ3
	λPER1.4	X1.1 = λIPER1.4 X1 + δ4
	λPER1.5	X1.1 = λIPER1.5 X1 + δ5
	λPER1.6	X1.1 = λIPER1.6 X1 + δ6
	λFTM.2.1	X2.1 = λFTM 2.1 X2 +δ7
X.2 Technical Factors	λFTM.2.2	X2.1 = λFTM 2.2 X2 +δ8
	λFTM.2.3	X2.1 = λFTM 2.3 X2 +δ9
	λFTM.2.4	X2.1 = λFTM 2.4 X2 +δ10
	λFTM.2.5	X2.1 = λFTM 2.5 X2 +δ11
	λFTM.2.6	X2.1 = λFTM 2.6 X2 +δ12
	λPEL3.1	X3.1 = λPEL3.1 X3 + δ13
	λPEL3.2	X3.1 = λPEL3.2 X3 + δ14
X.3 Project Implementation	λPEL3.3	X3.1 = λPEL3.3 X3 + δ15
	λPEL3.4	X3.1 = λPEL3.4 X3 + δ16
	λPEL3.5	X3.1 = λPEL3.5 X3 + δ17
	λPENG4.1	X4.1 = λPENG4.1 X4 + δ18
	λPENG4.2	X4.1 = λPENG4.1 X4 + δ19

X.4 Project Control	λPENG4.3	X4.1 = λPENG4.1 X4 + δ20
	λPENG4.4	X4.1 = λPENG4.1 X4 + δ21
	λPENG4.5	X4.1 = λPENG4.1 X4 + δ22
	λKP1.1	Y1.1 = λKP1.1 Y1 + ε1
Y.1 Project Performance	λKP1.2	Y1.2 = λKP1.2 Y1 + ε2
	λKP1.3	Y1.3 = λKP1.3 Y1 + ε3
	λKP1.4	Y1.4 = λKP1.4 Y1 + ε4
	λKP1.5	Y1.5 = λKP1.5 Y1 + ε5

IV. RESULT

In this study, 100 respondents with the aforementioned demographics were asked to respond to 28 questions using a Linkert scale ranging from 1 to 5, with the following summary:

Table 3: *Questionnaire Answer Result*

Variable	Indicator	Mean
Project Planning (X.1)	X.1.1	3,93
	X.1.2	4,09
	X.1.3	4,11
	X.1.4	4,15
	X.1.5	3,98
	X.1.6	4,14
Technical factors (X.2)	X.2.1	4,11
	X.2.2	3,88
	X.2.3	4,05
	X.2.4	3,98
	X.2.5	4,09
	X.2.6	4,08
Project Implementation (X.3)	X.3.1	4,11
	X.3.2	4,20
	X.3.3	4,13
	X.3.4	4,07
	X.3.5	4,02
Project Control (X.4)	X.4.1	4,07
	X.4.2	4,06
	X.4.3	4,01
	X.4.4	4,01
	X.4.5	3,99
Project Performance (Y.1)	Y.1.1	4,00
	Y.1.2	3,92
	Y.1.3	3,95
	Y.1.4	4,01
	Y.1.5	4,08
	Y.1.6	4,27

According to the variable description, the project planning variable (X1) in the X1.4 indicator has the highest average value of 4.15, with data suggesting that 31% (31 respondents) strongly agree, 57% (57 respondents) agree, 8% (8 respondents) are neutral, and 4% disagree (4 respondents). Strongly disagreeing with 0 replies, all agreed that material planning is a vital aspect of MEP project planning and has an impact on project performance.

Technical Factor Variable (X2) has the greatest average value of 4.11 on the X2.1 indicator, with data that strongly agree with 24% of respondents, agree with 66% of respondents, are neutral with 7% (7 respondents), disagree with 3% of respondents, and severely disagree with 24% of respondents. 0% of respondents agreed that the project management techniques and applications utilized by MEP are significant technical variables affecting project execution.

The average value of the Project Implementation Variable (X3) on the X3.2 indicator is 4.20. According to the data, 29% (29 respondents) highly agreed, 63% (63 respondents) agreed, 7% (7 respondents) were neutral, 1% (1 respondent) disagreed, and 0% strongly disagreed that the ability of manpower in the MEP project installation will impact project performance.

On the X4.1 indicator, Project Control Variable (X4) has the highest average value of 4.07, with data that strongly agrees with 21% of respondents (21), strongly agrees with 69% of respondents (69), is neutral at 6% (6 respondents), disagrees at 4% (4 respondents), and strongly disagrees with 21% of respondents. Change cannot be avoided in an MEP project, according to 0% of respondents, however improper change management, beginning with change initiation, change validation, change impact, and change approval, will negatively impact project performance.

Based on strongly agreed data, the Project Performance Variable (Y) for the Y1.6 indicator has the highest average value of 4.27, with 35% (21 respondents) agreeing, 59% (59 respondents) being neutral, 4% (4 respondents) disagreeing, and 2% (2 respondents) strongly disagreeing. 0% of those surveyed felt that project success enhances the company's reputation.

A. Outer loading model

Based on the outer loading of each variable indicator, the validity of the reflexive indicator as an elastic measure can be observed. If the outer loading value of an indicator is greater than 0.70, it is deemed to be of high reliability. (Ghozali & Latan, 2015).

Table 4: *Outer Loading Test*

Variable	X.1 Project Planning	X.2 Technical Factors	X.3 Project Implementation	X.4 Project Control	Y.1 Project Performance
X.1_1	0.766				
X.1_2	0.808				
X.1_3	0.836				
X.1_4	0.804				
X.1_5	0.762				
X1_6	0.861				
X2_1		0.731			
X2_2		0.575			
X2_3		0.796			
X2_4		0.778			
X2_5		0.794			
X2_6		0.725			
X3_1			0.738		
X3_2			0.798		
X3_3			0.743		
X3_4			0.854		
X3_5			0.764		
X4_1				0.752	
X4_2				0.769	
X4_3				0.689	
X4_4				0.638	
X4_5				0.751	
Y1_1					0.702
Y1_2					0.744
Y1_3					0.725

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Y1_4					0.768
Y1_5					0.816
Y1_6					0.795

Path Diagram based on Factor Loading illustrates the combination of all components of the SEM as a complete model of the measurement model and structural model, depicted as a flowchart to make it easier to see the causal relationships to be tested:

Path Diagram based on Factor Loading illustrates the combination of all components of the SEM as a complete model of the measurement model and structural model, depicted as a flowchart to make it easier to see the causal relationships to be tested:

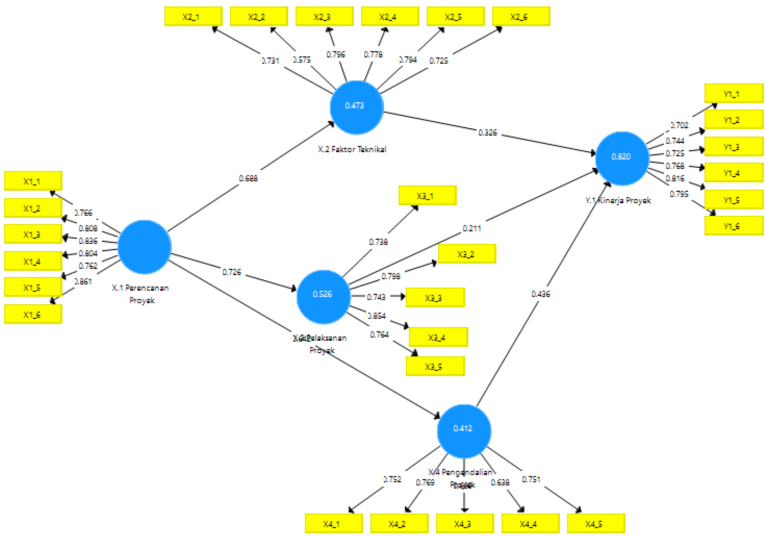

Figure 7: Path diagram based on factor loading

24 indicators remained for further testing out of the 28 total indicators at the start of operation. Four indicators were omitted; after removing the indicators that did not match the outer loading value of > 0.70, the outer loading was retested, and the results presented in Table 4 were obtained.

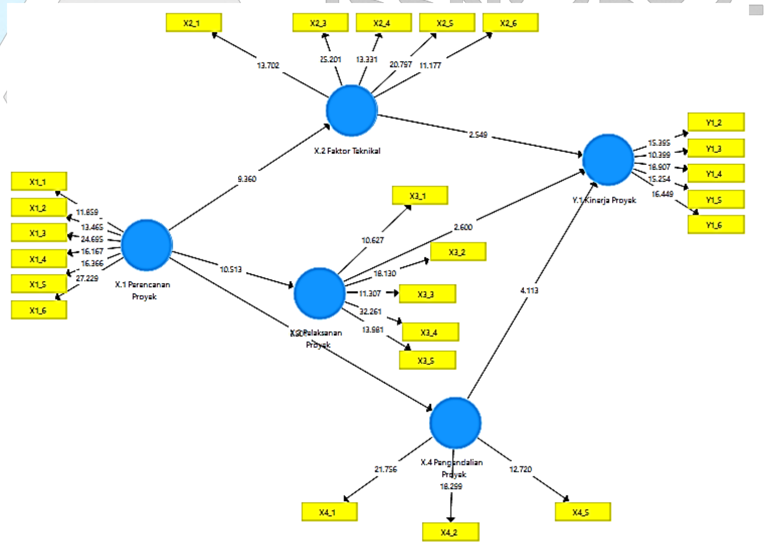

Figure 8: Path diagram based on factor loading Final

AVE measurement for testing the discriminant validity of the measurement model is performed by examining the cross loading value. A measurement is considered to have discriminant validity if it has a cross loading value of 0.70 or higher, as stated in.

Table 5: *Outer Loading Testing after revision*

Indicator	X.1 Project Planning	X.2 Technical Factors	X.3 Project Implementation	X.4 Project Control	Y.1 Project Performance
X.1._1	0.766				
X.1._2	0.807				
X.1._3	0.837				
X.1._4	0.804				
X.1._5	0.762				
X.1._6	0.861				
X.2._1		0.728			
X.2._3		0.823			
X.2._4		0.785			
X.2._5		0.814			
X.2._6		0.737			
X.3._1			0.733		
X.3._2			0.797		
X.3._3			0.746		
X.3._4			0.856		
X.3._5			0.764		
X.4._1				0.828	
X.4._2				0.821	
X.4._5				0.752	
Y.1._1					0.759
Y.1._2					0.719
Y.1._4					0.790
Y.1._5					0.843
Y.1._6					0.804

Table 6: *Cross loading value*

Indicator	Cross loading				
	X.1 Project planning	X.2 Technical Factors	X.3 Project Implementation	X.4 Project Control	Y.1 Project performance
X.1._1	0.766	0.541	0.544	0.477	0.527
X.1._2	0.807	0.553	0.602	0.491	0.495
X.1._3	0.837	0.530	0.563	0.466	0.462
X.1._4	0.804	0.457	0.541	0.447	0.447
X.1._5	0.762	0.502	0.576	0.460	0.464
X.1._6	0.861	0.607	0.667	0.585	0.576
X.2._1	0.535	0.728	0.617	0.615	0.647
X.2._3	0.559	0.823	0.689	0.564	0.645
X.2._4	0.457	0.785	0.562	0.475	0.647
X.2._5	0.498	0.814	0.578	0.531	0.633
X.2._6	0.527	0.737	0.657	0.572	0.498
X.3._1	0.622	0.602	0.733	0.573	0.547
X.3._2	0.590	0.613	0.797	0.544	0.638
X.3._3	0.584	0.545	0.746	0.579	0.608
X.3._4	0.554	0.720	0.856	0.664	0.712
X.3._5	0.475	0.628	0.764	0.643	0.630
X.4._1	0.527	0.589	0.623	0.828	0.659

X.4._2	0.472	0.532	0.637	0.821	0.660
X.4._5	0.461	0.585	0.589	0.752	0.612
Y.1._1	0.469	0.680	0.576	0.674	0.759
Y.1._2	0.377	0.577	0.595	0.629	0.719
Y.1._4	0.398	0.630	0.602	0.516	0.790
Y.1._5	0.514	0.602	0.656	0.611	0.843
Y.1._6	0.635	0.614	0.716	0.701	0.804

According to the table above, the cross-loading value in bold has a far higher value for the variable it creates than the values for other variables with a cross-loading value of 0.7, which range between 0.71 and 0.856. Thus, we may conclude that all of the markers have satisfied the standards and are suitable for further examination.

In addition to the cross-loading value, discriminant validity may also be assessed by examining the average variant extracted (AVE) value for each indicator; this value must be more than 0.5 for a model to be considered valid. The AVE value for the model is displayed in Table 6 below.

Table 7: *Average Variance Extracted (AVE)*

Variable	Average Variance Extracted (AVE)
X.1 Project planning	0.651
X.2 Technical Factors	0.606
X.3 Project Implementation	0.609
X.4 Project Control	0.642
Y.1 Project Performance	0.615

Due to the fact that the AVE value is more than 0.5, it is evident from the table that all variables' indications are deemed legitimate. The AVE values for the project planning variable, technical elements, project implementation, project control, and project performance are as shown in Table 7.

The value of the Fornell-Larcker criteria and the cross-loading value can also be used to conduct a discriminant validity test. According to the Fornell-Larcker criteria, the square root of the AVE value of each construct must be greater than the correlation value between constructs. According to Sarwono (2007), the Fornell-Larcker criteria are utilised to guarantee discriminant validity, and the AVE for each latent variable must be bigger than the R2 of all other latent variables. Consequently, with each indicator block, each latent variable provides a greater number of types than other latent variables that reflect conflicting indicator blocks. The Fornell-Larcker criterion results are presented in Table 8 below:

Table 8: *Fornell-larcker Criterion Value*

Variable	Fornell-larcker criteria				
	X.1 Project planning	X.2 Technical Factors	X.3 Project Implementation	X.4 Project Control	Y.1 Project performance
X.1 Project planning	0.807				
X.2 Technical Factors	0.663	0.778			
X.3 Project Implementation	0.725	0.798	0.780		
X.4 Project Control	0.608	0.709	0.769	0.801	
Y.1 Project performance	0.617	0.793	0.805	0.803	0.784

Table 5 demonstrates that the square root of AVE is greater than the value of the correlation between latent variables.

Ø Reliability Test (Composite Reliability)

Composite reliability is the component used to evaluate the value of indicator dependability on a variable. If the combined reliability value is greater than 0.70, a latent variable can be deemed trustworthy. As a rule of thumb, the overall reliability value must be larger than 0.70 when evaluating the dependability of a structure. Composite reliability possesses a degree that indicates joint latent (unobserved), enabling it to serve as a block indicator that measures the internal consistency of construct-forming indicators. The obtained limit value for the level of composite reliability is 0.70. It is not, however, an absolute standard. Table 9 displays the model's overall reliability rating.

Table 9: *Composite Reliability Value*

Variable	Composite Reliability
X.1 Project planning	0.918
X.2 Technical Factors	0.885
X.3 Project Implementation	0.886
X.4 Project Control	0.843
Y.1 Project performance	0.888

According to the data shown in Table 6, the Cronbach's alpha value for each variable is 0.70. In this way, these results can indicate that each research variable has met the requirements for the Cronbach's alpha value, so it can be concluded that each variable's indicator is reliable, accurate, consistent, and suitable for measuring variables.

Ø Inner Model

Evaluate the internal model and examine the structural model to determine the direct and indirect effects of supplementary variables. In this study, we will discuss the path coefficient test, the goodness-of-fit test, and the hypothesis test..

Ø Coefficient of Determination (R2) and Goodness Of Fit (Q2)

Evaluation of the Coefficient of Determination (R2) is employed to demonstrate the extent of the effect or influence of the independent variables on the dependent variable. Chin stated that endogenous latent variables in the structural model with an R2 value of 0.67 or greater indicated a "good" influence of exogenous variables on endogenous variables. Meanwhile, if the result is between 0.33 and 0.67, it is classified as medium, and if it is between 0.19 and 0.33, it is classified as weak. The model's R-Square value is shown in Table 11 below.

Table 10: *R-Square value*

Variable	R Square
X.1 Project Planning	0
X.2 Technical Factors	0.439
X.3 Project Implementation	0.525
X.4 Project Control	0.370
Y.1 Project performance	0.765

Source: Data processed, (2022)

The response variable (X2) achieved an R-squared value of 0.439%, as seen in the table above. This indicates that the predictor variable, namely project planning (X1), can explain 43.9% of the project technical aspects (X2). The remaining, or 56.1% (100% - 43.9% = 56.1%), is impacted by non-technical variables. The R-Square value for the project implementation response variable (X3) is 0.525. This indicates that the magnitude of the predictor variable, namely project planning (X1), can explain the 52.5% implementation rate (X3). While the remaining 47.5% (100% - 52.5% = 47.5%) is affected by circumstances outside the scope of the research model. The R-Square value for the response variable Project Control (X4) is 0.37. This indicates that the magnitude of the predictor variable, namely project planning (X1), may explain the 37% value of project monitoring and control (X4). Other factors influence the remaining 63% of the relationship between planning and project control (100% - 37% = 63%).

The R-Square value of the project performance (Y) response variable was 0.76. This indicates that 76.5% of predictor variables, including project technical elements (X2), project implementation (X3), and project control (X4), may simultaneously explain project performance (Y). While the remaining 23.5% (100 minus 76.5 =

23.5%) is influenced by factors outside the research model, such as project planning, project implementation, project monitoring, and project performance control, the remaining 76.55% (75% minus 100% = 76.5%) is influenced by variables within the research model.

The Q^2 value can be used to assess the fit quality. The Q^2 number corresponds to the coefficient of determination (R-Square) in regression analysis, where the larger the R-Square, the better the model's ability to fit the data. The formula for calculating Q^2 is as follows: Hair et al (2011):

$$Q^2 = 1 - (1 - R12)$$
$$Q^2 = 1 - (1\text{-}0{,}765)$$
$$= 1 - (0{,}235)$$
$$= 1 - 0.235$$
$$= 0{,}765$$

The computation reveals that the value of Q2 is 0.7655. 76.5 percent is the proportion of the research data's diversity that can be characterised by the structural model created in this study. Based on these findings, this study's structural model has a high degree of match. The GoF values range from 0 to 1, and are interpreted as follows: 0.1 (little GoF), 0.25 (mid GoF), and 0.36 (big GoF) (large GoF). (Zali and Latan: 2012).

Hypothesis Testing

Once the data meets the measurement requirements, the bootstrapping method in SmartPLS 3.3.5 can be applied. The bootstrapping procedure takes N new samples from the original data of size n, where for each new sample, a sample point is retrieved one by one from the original data n times. Whether or not a hypothesis is accepted, the bootstrapping function in SmartPLS 3.3.5 must be used to test it. When the significance level is less than 0.05 or the t-value exceeds the critical value, an idea is conceived. Using the t-statistical coefficient, the following is a path diagram of the bootstrapping results generated by the smartPLS application.

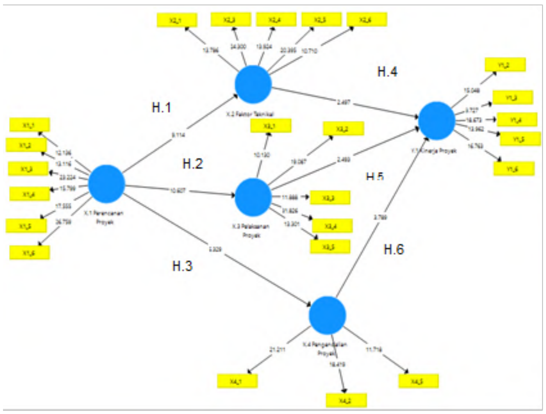

Figure 10: *Bootstrapping result path diagram*

The research findings can be utilised to test the study's hypothesis in light of the data processing that has been performed. This study's hypothesis was accepted if the T-Statistics value was greater than the T table, which was determined by comparing the T-Statistics value to the T table.

Hypothesis:

- H0: There is no partial relationship between the independent variables and the dependent variable
- H1: There is a partial relationship between the independent variables and the dependent variable.

Discernment Criteria:

✓ If the value of T-Statistics is T table (t = 0.05.62) = 1.999, then H0 is approved.

✓ H1 is acceptable if the value of the T-Statistics T table is t (0.05, 62) = 1.999.

Table 11: *Results test hypothesis*

Hypothesis	Track	Coefficient Path	T Statistics	Description
H1	X.1 Project Planning -> X.2 Technical Factors	0.663	9.114	take effect positive and Significant
H2	X.1 Project Planning -> X.2 Project Implementation	0.722	10.607	take effect positive and Significant
H3	X.1 Project Planning -> X.4 Project Control	0.599	6.329	take effect positive and Significant
H4	X.2 Technical Factors -> Y.1 Project Performance	0.316	2.497	take effect

				positive and Significant
H5	X.2 Project Implementation -> Y.1 Project Performance	0.270	2.493	take effect positive and Significant
H6	X.4 Project Control -> Y.1 Project Performance	0.374	3.789	take effect positive and Significant

Source: Data is processed (2022)

The values for H1, H2, H3, H4, H5, and H6's path coefficients are more than 0.1 and are positive. Consequently, all hypotheses have a favourable impact. In the meantime, the significance value is shown by the t-statistic > 1.99 and p-value f 0.05. According to the preceding data, H1, H2, H3, H4, H5, and H6 all have significant values.

According to Sugiono (2017), correlation is divided into five categories: very low correlation with a coefficient value between 0.00 and 0.199; low correlation with a coefficient value between 0.20 and 0.399; moderate correlation with a coefficient value between 0.40 and 0.599; high correlation with a coefficient value between 0.60 and 0.799; and very high correlation with a coefficient value between 0.80 and 0.999.

Ø Indirect Effect Analysis (total indirect effect)

Based on the smartPLS application's data processing, it is also evident that the independent variable (project planning) indirectly affects the dependent variable (project performance). Using the same hypothesis and decision-making criteria, the total indirect effect may be described as follows.

Table 12: *The total value of the indirect effect*

Indirect Relationship	Coefficient Path	T Statistics	Description
X.1 Project Planning -> Y.1 Project Performance	0.626	8.173	Signifikan

Source: Data is processed, (2022)

Indirectly, the influence of project planning on project performance exhibits a positive path coefficient of 0.626, as seen in Table 13. T-statistics (8.173) > T-table (1.999) is also known to indicate that hypothesis H0 is rejected and hypothesis H1 is accepted. This indicates that there is an indirect but considerable beneficial relationship between project planning and project performance. This implies that the better the planning, the better the performance of the project. If the value of project planning is diminished, the performance of the project will also be diminished.

V. CONCLUSION

Ø Conclusion

The situation can be summarized as follows, based on the research findings:

- Evaluation of the coefficient of determination shows that planning can explain that the technical factor is 43.9% ,Technical element is positively and significantly affected by project planning is of 66,3%. The greater the value of project planning, the greater the value of technical components. If the project planning value is lower, then the technical factor will also be lower.
- Evaluation of the coefficient of determination shows that planning can explain that the Execution is 52.5% ,Planning has a favourable and substantial influence on Execution of 72.2% . This indicates that the value of project implementation increases proportionally to the value of project planning. If the value of project planning is reduced, the value of project implementation will also drop.
- Evaluation of the coefficient of determination shows that planning can explain that the Control is 37% , Planning has a significant and positive impact on Control of 59.9% . This implies that the project control value will increase according to the project planning value. If the project planning value is lower than the project control value, the project control value will decline.
- Positive and strong influence of project technical parameterson project performance is 31.6%. This illustrates that the more the value of the project's technical aspects, the greater the value of the project's performance. If the technical aspects of a

project have a lesser value, the project's performance will decline.

- Implementation of has a good and substantial impact on project performance is 27%. This explains that the project performance value will increase proportionally to the project implementation value. If the value of a project's technical aspects decreases, the project's performance will also decline.
- Control has a strong and favourable impact on project performance is 37.4% . This indicates that the project performance value increases proportionally to the project implementation value. If the value of a project's technical aspects decreases, the project's performance will also decline.
- Evaluation of the coefficient of determination shows that planning can explain that the project performance is 76.1%, Indirectly Planning has a substantial favourable effect on project performance of 62.6%. This explains why the value of project implementation increases with the value of project planning. Inversely, if the value of project planning is lower, project performance would decline.

Ø Suggestion

Based on the limitations of this investigation, the researchers recommend the following enhancements for future studies:

- Project performance can be improved by improving the indicators on the timeliness of Material Onsite, design accuracy of Engineering, Manpower Capability, and cost accuracy. The above can be achieved by carrying out well-organized planning, technical factors, implementation, and control to minimize errors in both the process and the results.
- The population in this study came from various divisions in the MEP Contractor, so in distributing the questionnaire it is suggested to be assisted or explained in advance in each statement/indicator so that respondents can understand the meaning of these statements.
- This study employs both causal and quantitative approaches. Therefore, it is proposed that the number of participants in the subsequent study be raised so that the analysis will be more reliable.
- For follow-up research utilising a complete conceptual model where moderating effects can be added prior to project performance, it is recommended that additional research be conducted in multiple companies with similar businesses so that the results of this research can be implemented in other businesses.

REFERENCES

[1] Larasati,D. A., & Sutopo, W. (2020). "Analisis Efektivitas Jadwal Proyek Implementasi Software dengan Critical Path Method: Studi Kasus. Jurnal INTECH Teknik Industri Universitas Serang Raya", 6(1), 55-64.

[2] Thomas,M.,Jacques,P.H.,Adams,J.R.,&Kihneman-Wooten, J. (2008). "Developing an effective project: Planning and team building combined. Project Management "Journal, 39(4), 105-113.

[3] Xu, X., Zhang, W., & Barkhi, R. (2010)." IT infrastructure capabilities and IT project success:a development team perspective. Information Technology and Management", 11(3), 123-142.

[4] Zulfaika, Z. (2018)." Hubungan Kinerja Tim Dan Keberhasilan Proyek Konstruksi. Jurnal Teknik Sipil dan Teknologi Konstruksi", 4(1).

[5] Eatsman,C. Teicholz, P. Sacks, R. Liston, K., (2008). "BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors". 2008 by John Wiley & Sons

[6] Syahrully,Rezti Miranty,Octoberry Julyanto, Edna Maryani, and Donny Sanjaya."Analysis of Machine Design Project Scheduling Ncb 8 Critical Path Method (Cpm) Load and Method of Manufacturing Oriented Control (Lomc) in Pt. XXX." International Journal of Innovative Science and Research Technology 5, no. 1 (2020): 1048–55. www.ijisrt.com.

[7] Syahputri, K., P. Mukhlidani, R. M. Sari, and I. Rizkya. "Optimization of Sei Wampu Dam Project Schedule Using Critical Path Method." IOP Conference Series: Materials Science and Engineering 851,no.1(2020). https://doi.org/10.1088/1757899X/851/1/012054.

[8] Jiang, Yunxia. "Analysis and Consideration of Construction Project Management Course on Building Information Modeling" 516,no Iserss 2020 (2021): 402–8.

[9] Maulana, Ardabil, and Fredy Kurniawan. "Time Optimization Using Cpm, Pert and Pdm Methods in the Social and Department of Kelautan Building Development Project Gresik District." IJTI (International Journal of Transportation and Infrastructure) 2, no. 2 (2019):57–66. https://doi.org/10.29138/ijti.v2i2.784.

[10] Karabulut, Mertcan. "Application of Monte Carlo Simulation and PERT/CPM Techniques in Planning of Construction Projects: A Case Study." Periodicals of Engineering and Natural Sciences 5, no. 3 (2017): 408–20. https://doi.org/10.21533/pen.v5i3.152.

[11] Kusumadarma, Indri Alvi, Devi Pratami, I Putu Yasa, and Wawan Tripiawan. "Developing Project Schedule in Telecommunication Projects Using Critical Path Method (CPM)" 3 (2020): 60–67.

[12] Ashok Kumar, V. K., and L. S. Ganesh. "Use of Petri Nets for Resource Allocation in Projects." IEEE Transactions on Engineering Management 45, no. 1 (1998): 49–56. https://doi.org/10.1109/17.658660.

[13] Aziz, Remon Fayek. "RPERT: Repetitive-Projects Evaluation and Review Technique." Alexandria Engineering Journal 53, no. 1 (2014): 81–93. https://doi.org/10.1016/j.aej.2013.08.003.

[14] Karabulut, Mertcan. "Application of Monte Carlo Simulation and PERT/CPM Techniques in Planning of Bisnis, Administrasi, Fakultas Ilmu, Ilmu Politik, and Yuliarty, Popy. "Construction Service Project Scheduling Analysis Using Critical Path Method (CPM), Project Evaluation and Review Technique (PERT)" 6, no. 2 (2021): 2019–22.

[15] Construction Projects: A Case Study." Periodicals of Engineering and Natural Sciences 5, no. 3 (2017): 408–20. https://doi.org/10.21533/pen.v5i3.152.

[16] Kiki Lumban Gaol, Agustinus Hariadi Dwojoko Purwanto (2021). " Peningkatan kinerja proyek pengembangan perangkat lunak (Software) melalui perencanaan proyek, faktor teknikal, kapabilitas tim dan ruang lingkup proyek"Dinasti Internasional journal Of Digital Businsess Management , Volume 1, Issue 6, October 2020 ,DOI: 10.31933/DIJDBM

[17] Dedy Waskita,Agustinus Hariadi Dwojoko Purwanto (2022). " Peningkatan Kinerja Proyek melalui Project Maturity Level , Perencanaan , Pelaksanan, Pemantauan dan Pengendalian Proyek". International Journal of Innovative Science and Research Technology Volume 7, Issue 7, July – 2022 ISSN No:-2456-2165.