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Analysis Of The Impact Of The Covid-19 Pandemic On The Construction Industry Sector (A Case Study Construction Project RSUD Soedono Madiun)

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Abstract

Accelerating infrastructure development in Indonesia is a good thing, but this is not without problems. The COVID-19 pandemic is a problem that has a large and global impact, not least in Indonesia, especially in the construction industry sector. The construction project of the Soedono Madiun Hospital is one of the construction projects that have experienced the direct impact of the COVID-19 pandemic. Therefore, the purpose of this study is to review and analyze the impact of the covid-19 pandemic on construction projects in the case study of the construction project of the Soedono Madiun Hospital, and to find out the biggest impact of the covid-19 pandemic which has the most influence on construction projects in the case study of the construction project of the Soedono Hospital. The research method used to determine the biggest impact of the covid-19 pandemic on the cost and time aspects is the multiple linear regression analysis method with the help of Microsoft Excel. The other data analysis methods used in this study were the validity and reliability tests used in testing the questionnaire. The results of data analysis conducted in this study indicate that there are seven independent variables affect the dependent variable, namely the suitability of planning and project realization with the equation $y = 94.186 - 0.376x_1 - 0.108x_2 - 1.014x_3 + 0.873x_4$ for the time aspect, and the equation $y = 87,009 - 0.0006x_5 - 0.001x_6 - 0.0002x_7$ for the cost aspect. With this equation, it can be seen that the independent variable that has the most influence on the dependent variable on the time aspect is the independent variable X3, namely the change in the time schedule due to delays in the arrival of construction materials by 1.014, while in the cost aspect is the independent variable X6, namely changes in costs due to instability. the price of construction materials is 0.001. So, it is hoped that there will be a project management handling that focuses on the most influential variable, namely construction materials.

Keywords:

Construction Projects, Covid-19 Pandemic, Project Management, Infrastructure, Materials Construction

1. Introduction

As a country that occupies the fourth-highest position in terms of population density, Indonesia is still not fully developed as a developed country. Some of the conditions that make a country not yet fully developed include the following characteristics: low income, low standard of living, low community productivity, high population growth rate, dependence on foreign parties, and high unemployment, the majority of the population depends on the primary and agricultural product sectors, is weak in the aspect of international relations, the lack of capital used for development, the availability of work land and labor is not balanced, the application of technology that is not suitable with the situation and conditions in the local country, and so on. Therefore, various efforts have been made to make Indonesia better, and to make Indonesia a developed country following Indonesia's vision of 2045.

The first requirement for Indonesia to be able to become a developed country is to provide adequate infrastructure to support mobility and support development Antara and Widyastuti (2019). The acceleration of infrastructure development is not only meant to catch up but also to grow new economic centers that can provide added value to regions throughout the country Kusuma (2018). However, in practice, infrastructure development in Indonesia is also inseparable from various problems.

In 2020, Indonesia and other countries around the world will feel the COVID-19 pandemic. This also has an impact on the construction industry sector, namely on infrastructure development in Indonesia. Any impact or influence caused by the problem must be immediately identified and the level of influence analyzed so that the priority of handling problems that occur will be right on target and problems can be resolved immediately. Therefore, the author decided to conduct a study with the title "Analysis of the Impact of the Covid-19 Pandemic on the Construction Industry Sector (A Case Study of the Soedono Madiun Hospital Development Project)".

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In this study, several basic theories and formulas were used as references and writing references, including the suitability of planning and realization of construction projects, validity test Santoso (2012), reliable test Arikunto (1996), multiple regression analysis method Ahmaddien, Iskandar & Syarkani (2019) as stated below:

$$\text{suitability of planning \& realization} = 100\% - \% \text{ difference between realization and planning} \dots\dots\dots(1)$$

$$\% \text{ difference between realization and planning} = \left(\frac{\text{difference duration realization and planning}}{\text{total planning duration}} \times 100\% \right) \dots\dots\dots(2)$$

$$\% \text{ difference between realization and planning} = \left(\frac{\text{difference cost realization and planning}}{\text{total planning cost}} \times 100\% \right) \dots\dots\dots(3)$$

$$r = \frac{n \Sigma xy - \Sigma x \Sigma y}{\sqrt{[n \Sigma x^2 - (\Sigma x)^2][n \Sigma y^2 - (\Sigma y)^2]}} \dots\dots\dots(4)$$

$$t_{count} = \frac{r \cdot \sqrt{n-2}}{\sqrt{1-r^2}} \dots\dots\dots(5)$$

$$\Sigma ab^2 = \frac{\Sigma xi^2 - \frac{(\Sigma x)^2}{n}}{n} \dots\dots\dots(6)$$

$$at^2 = \frac{\Sigma y^2 - \frac{(\Sigma y)^2}{n}}{n} \dots\dots\dots(7)$$

$$r_n = \left(\frac{k}{k-1} \right) \cdot \left(1 - \frac{\Sigma ab^2}{at^2} \right) \dots\dots\dots(8)$$

$$\Sigma xi^2 = \Sigma xi^2 - \frac{(\Sigma xi)^2}{n} \dots\dots\dots(9)$$

$$\Sigma xi \cdot y = \Sigma xi \cdot y - \frac{\Sigma xi \cdot \Sigma y}{n} \dots\dots\dots(10)$$

$$b = \frac{[(\Sigma x1^2 \cdot \Sigma x2y) - (\Sigma x1y \cdot \Sigma x2x1)]}{[(\Sigma x2^2 \cdot \Sigma x1^2) - (\Sigma x2 \cdot \Sigma x1)^2]} \dots\dots\dots(11)$$

$$a = \frac{\Sigma y - (b1 \cdot \Sigma x1) - (b2 \cdot \Sigma x2) - (b3 \cdot \Sigma x3)}{n} \dots\dots\dots(12)$$

$$Y = a + b1X1 + b2X2 + \dots + bnXn \dots\dots\dots(13)$$

information :

- r : correlation coefficient
- Y : dependent variable
- Xi : independent variable element
- n : number of respondents
- r_n : instrument reliability (coefficient)
- k : number of questions
- Σab^2 : number of item variants
- at^2 : total variance
- ΣXi : total score of the variables reviewed
- Y : dependent variable
- $X1, X2$: independent variable
- a : constant
- $b1, b2$: regression coefficient (increase or decrease value)

2. Methodology

The method used in this study is the multiple regression analysis method as stated in the introduction, but this chapter will explain several things that also support this method, namely research variables, and data collection techniques. The variables used in this study are based on construction project problems that occurred as a result of the COVID-19 pandemic on the Soedono Hospital construction project and can be explained as follows :

1. The independent variable or also known as the independent variable (X) in the form of changes in the time schedule due to the physical distancing policy made by the government (X1), changes in the time schedule due to delays in the arrival of workers (X2), changes in the time schedule due to delay in the arrival of construction materials (X3), changes in the time schedule due to delays in the arrival of construction equipment (X4), budget reduction provided by the government (X5), changes in costs due to instability in construction material prices (X6), changes in costs due to increases in equipment rental prices construction (X7)
2. The dependent variable or also known as the dependent variable (Y) is the suitability of planning and project realization. The suitability of the intended project planning and realization is described in the form of a percentage that represents conformity with the initial planning, in terms of both cost and time aspects.
3. The data collection techniques used in this research are :
4. Literature study, namely collecting data from lecture materials, textbooks, reference books, and journals to obtain information and basic theories related to research

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5. Interviews, namely data collection with questions and answers conducted with Mr. Anang, as the project manager of the contractor implementing the construction of RSUD Soedono Madiun, namely PT. Jaya Semanggi Engineering and 4 other people from the implementing subcontractors (Pak Iqbal, Pak Didik, Pak Udin, Pak Hadi, Pak Joko) to determine construction project problems.
6. Dissemination of Questionnaires, namely data collection by distributing a list of written questions to the parties involved in the construction project of RSUD Soedono Madiun which had been carefully prepared in advance to meet the needs of researchers in obtaining information in the form of data to be processed and analyzed. As for this distribution, it uses the Google Form site tool in its distribution. The google form site that is used can be accessed via the link: bit.ly/ImpactofPandemiPadaConstruction. There are several stages carried out by researchers in distributing questionnaires, namely researchers asking respondents' consent to fill out questionnaires, researchers explaining the purpose and general description of the questions asked, researchers explaining procedures for filling out questionnaires that have been distributed, and providing opportunities for questionnaires to study and ask if there are things that are not understood in the questionnaire, the researcher will collect answers from respondents to be processed and analyzed as material for considering the impact of covid-19 which has the most influence on the construction project of the Soedono Madiun Hospital. Each answer choice listed on the questionnaire has a different weight, this can be explained in the table below:

Table 1. Questionnaire Answer Choice Scores

No	Answer Choices	Score
1	Strongly Agree	4
2	Agree	3
3	Less Agree	2
4	Disagree	1

3. Result and Discussion

The first step in this research is the validity test. In the study, all the questions listed in the questionnaire will pass the validity test stage. The validity test is carried out in several stages. Several of these stages were carried out on all question items that represented the independent variables. Based on the results of the validity test for all questions that represent the independent variables in this study, it can be seen that all statement items have a higher t_{count} value when compared to t_{table} . So, it can be concluded that all question items are declared valid. Because all variables have passed the validity test stage and are declared valid in their calculations, the accuracy level of all variables to be used in this data reveals that the variables are efficient and appropriate, and are suitable for use as research material.

Table 2. Validity Test

Question Number	n	ΣXY	ΣX	ΣY	ΣX^2	ΣY^2	r count	t count	t table	Result
1	17	4316	53	1374	189	112150	0.2002411	0.791562	0.482	Valid
2	17	3891	48	1374	162	112150	0.0672682	0.52224	0.482	Valid
3	17	3376	41	1374	121	112150	0.3992759	1.686668	0.482	Valid
4	17	3909	48	1374	158	112150	0.1875804	0.739624	0.482	Valid
5	17	4492	55	1374	189	112150	0.4237629	1.811962	0.482	Valid
6	17	4265	52	1374	176	112150	0.455785	1.983224	0.482	Valid
7	17	4235	52	1374	164	112150	0.4367461	1.880323	0.482	Valid
8	17	4355	53	1374	181	112150	0.542219	2.4993	0.482	Valid
9	17	4885	60	1374	216	112150	0.5217596	2.368754	0.482	Valid
10	17	4973	61	1374	225	112150	0.5216738	2.368219	0.482	Valid
11	17	4636	57	1374	195	112150	0.4449757	1.924401	0.482	Valid
12	17	4826	59	1374	213	112150	0.6036249	2.932298	0.482	Valid
13	17	4590	57	1374	201	112150	-0.162599	0.638239	0.482	Valid
14	17	4900	60	1374	220	112150	0.5318826	2.432603	0.482	Valid
15	17	4900	60	1374	220	112150	0.5318826	2.432603	0.482	Valid
16	17	4609	57	1374	197	112150	0.0256123	0.496144	0.482	Valid
17	17	4557	56	1374	192	112150	0.3395749	1.398254	0.482	Valid
18	17	3593	44	1374	126	112150	0.3186601	1.302042	0.482	Valid
19	17	3883	48	1374	142	112150	0.0411658	0.797849	0.482	Valid
20	17	3509	43	1374	123	112150	0.2686023	1.07998	0.482	Valid
21	17	4580	56	1374	192	112150	0.5924774	2.848426	0.482	Valid
22	17	4092	50	1374	160	112150	0.426269	1.825049	0.482	Valid
23	17	3895	48	1374	146	112150	0.1442537	0.564598	0.482	Valid
24	17	4100	50	1374	158	112150	0.5365681	2.462644	0.482	Valid
25	17	4580	56	1374	192	112150	0.5924774	2.848426	0.482	Valid
26	17	4177	51	1374	161	112150	0.58671	2.806034	0.482	Valid
27	17	3658	45	1374	131	112150	0.1832971	0.722142	0.482	Valid
28	17	4100	50	1374	158	112150	0.5365681	2.462644	0.482	Valid

The reliability test was carried out after conducting the validity test. Broadly speaking, this reliability test is carried out in three stages, starting from finding the value of r_n as the alpha coefficient, comparing it with the value of r_{table} , then determining the reliability decision of each data being tested. Based on the results of the reliability test for all questions that represent the independent variables in this study, it can be seen that all statement items have a greater r_n value when compared to r_{table} . So, it can be concluded that all question items are declared reliable. Because all variables have passed the reliability test stage and are declared reliable in the proof and calculations, the accuracy of all the variables that will be used in this data reveals that the variables can be trusted and deserve to be used as research material.

Table 3. Reliability Test

Question Number	n	ΣXY	ΣX	ΣY	ΣXi ²	ΣYi ²	Σab ²	at ²	r count	r table	Result
1	17	4316	53	1374	189	112150	1.3979239	64.61592	1.0146	0.482	Reliable
2	17	3891	48	1374	162	112150	1.5570934	64.61592	1.012	0.482	Reliable
3	17	3376	41	1374	121	112150	1.3010381	64.61592	1.0162	0.482	Reliable
4	17	3909	48	1374	158	112150	1.3217993	64.61592	1.0158	0.482	Reliable
5	17	4492	55	1374	189	112150	0.650519	64.61592	1.0266	0.482	Reliable
6	17	4265	52	1374	176	112150	0.9965398	64.61592	1.021	0.482	Reliable
7	17	4235	52	1374	164	112150	0.2906574	64.61592	1.0324	0.482	Reliable
8	17	4355	53	1374	181	112150	0.9273356	64.61592	1.0222	0.482	Reliable
9	17	4885	60	1374	216	112150	0.2491349	64.61592	1.033	0.482	Reliable
10	17	4973	61	1374	225	112150	0.3598616	64.61592	1.0313	0.482	Reliable
11	17	4636	57	1374	195	112150	0.2283737	64.61592	1.0334	0.482	Reliable
12	17	4826	59	1374	213	112150	0.4844291	64.61592	1.0293	0.482	Reliable
13	17	4590	57	1374	201	112150	0.5813149	64.61592	1.0277	0.482	Reliable
14	17	4900	60	1374	220	112150	0.4844291	64.61592	1.0293	0.482	Reliable
15	17	4900	60	1374	220	112150	0.4844291	64.61592	1.0293	0.482	Reliable
16	17	4609	57	1374	197	112150	0.3460208	64.61592	1.0315	0.482	Reliable
17	17	4557	56	1374	192	112150	0.4429066	64.61592	1.0299	0.482	Reliable
18	17	3593	44	1374	126	112150	0.7128028	64.61592	1.0256	0.482	Reliable
19	17	3883	48	1374	142	112150	0.3806228	64.61592	1.0309	0.482	Reliable
20	17	3509	43	1374	123	112150	0.8373702	64.61592	1.0236	0.482	Reliable
21	17	4580	56	1374	192	112150	0.4429066	64.61592	1.0299	0.482	Reliable
22	17	4092	50	1374	160	112150	0.7612457	64.61592	1.0248	0.482	Reliable
23	17	3895	48	1374	146	112150	0.615917	64.61592	1.0272	0.482	Reliable
24	17	4100	50	1374	158	112150	0.6435986	64.61592	1.0267	0.482	Reliable
25	17	4580	56	1374	192	112150	0.4429066	64.61592	1.0299	0.482	Reliable
26	17	4177	51	1374	161	112150	0.4705882	64.61592	1.0295	0.482	Reliable
27	17	3658	45	1374	131	112150	0.6989619	64.61592	1.0258	0.482	Reliable
28	17	4100	50	1374	158	112150	0.6435986	64.61592	1.0267	0.482	Reliable

Furthermore, the calculation of the percentage of suitability of the planning and project realization that will be used as the dependent variable in multiple linear regression analysis with an error correction factor of 5% as follows:

$$\begin{aligned}
 \text{Suitability of Planung\&Realization} &= 100\% - \% \text{ Difference Planung\&Realization} \\
 \text{Suitability of Planung\&Realization} &= 100\% - \left(\frac{\text{difference planning\&realization}}{\text{total planning cost}} \times 100\% \right) \\
 \text{Suitability of Planung\&Realization} &= 100\% - \left(\frac{\text{Rp } 239.513.965,69}{\text{Rp } 1.974.688.896,95} \times 100\% \right) \\
 \text{Suitability of Planung\&Realization} &= 100\% - 12,1292\% \\
 \text{Suitability of Planung\&Realization} &= 87,8708\% \\
 \text{Suitability of Planung\&Realization} &= 100\% - \% \text{ Difference Planung\&Realization} \\
 \text{Suitability of Planung\&Realization} &= 100\% - \left(\frac{\text{difference planning\&realization}}{\text{total planning duration}} \times 100\% \right) \\
 \text{Suitability of Planung\&Realization} &= 100\% - \left(\frac{4 \text{ weeks}}{32 \text{ weeks}} \times 100\% \right) \\
 \text{Suitability of Planung\&Realization} &= 100\% - 12,5\% \\
 \text{Suitability of Planung\&Realization} &= 87,5\%
 \end{aligned}$$

The next stage is multiple linear regression analysis. Multiple linear regression analysis is used to determine the effect of time changes on the time schedule due to the physical distancing policy made by the government (X1), changes in the time schedule due to delays in the arrival of workers (X2), changes in the time schedule due to delays in the arrival of construction materials. (X3), changes in the time schedule due to delays

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in the arrival of construction equipment (X4), budget reduction provided by the government (X5), changes in costs due to instability in construction material prices (X6), changes in costs due to increases in construction equipment rental prices (X7) on the dependent variable (Y) in the form of the suitability of planning and project realization. Several stages are carried out in making multiple regression linear analysis calculations, which can be described as follows :

Determine the value of constants and regression coefficients

The calculation is divided into two, namely the cost and time aspects. While the value of each variable to be calculated is taken from the sum of the scores from the answers to the questionnaire questions that support these variables.

Table 4. Recapitulation of Total Variable Values and Multiplication of Time Aspects

N	Y	x1	x2	x3	x4	x1 ²	x2 ²	x3 ²	x4 ²	Y ²	X1xX2xX3xX4	X1 Y	X2 Y	X3 Y	X4 Y
1	82.5	12	14	15	14	144	196	225	196	6806.3	35280	990	1155	1238	1155
2	83.5	11	12	14	11	121	144	196	121	6972.3	20328	918.5	1002	1169	918.5
3	84.5	16	16	16	16	256	256	256	256	7140.3	65536	1352	1352	1352	1352
4	85.5	13	15	15	15	169	225	225	225	7310.3	43875	1112	1283	1283	1283
5	86.5	13	12	12	12	169	144	144	144	7482.3	22464	1125	1038	1038	1038
6	87.5	7	15	16	15	49	225	256	225	7656.3	25200	612.5	1313	1400	1313
7	88.5	8	13	13	16	64	169	169	256	7832.3	21632	708	1151	1151	1416
8	89.5	14	15	10	10	196	225	100	100	8010.3	21000	1253	1343	895	895
9	90.5	13	9	15	16	169	81	225	256	8190.3	28080	1177	814.5	1358	1448
10	91.5	12	15	16	16	144	225	256	256	8372.3	46080	1098	1373	1464	1464
11	92.5	7	11	12	13	49	121	144	169	8556.3	12012	647.5	1018	1110	1203
12	82.5	16	16	16	16	256	256	256	256	6806.3	65536	1320	1320	1320	1320
13	83.5	13	9	12	12	169	81	144	144	6972.3	16848	1086	751.5	1002	1002
14	84.5	16	16	16	12	256	256	256	144	7140.3	49152	1352	1352	1352	1014
15	85.5	10	10	11	10	100	100	121	100	7310.3	11000	855	855	940.5	855
16	86.5	5	8	16	16	25	64	256	256	7482.3	10240	432.5	692	1384	1384
17	87.5	4	6	12	14	16	36	144	196	7656.3	4032	350	525	1050	1225
Σ	1473	190	212	237	234	2352	2804	3373	3300	127696	498295	16387	18335	20505	20284

Tabel 5. Recapitulation of Total Variable Values and Multiplication of Cost Aspect

N	Y	x5	x6	x7	x5 ²	x6 ²	x7 ²	Y ²	X5xX6xX7	X5 Y	x6 Y	x7 Y
1	82.871	12	15	13	144	225	169	6867.603	2340	994.45	1243.065	1077
2	83.871	15	12	11	225	144	121	7034.345	1980	1258.1	1006.452	922.6
3	84.871	9	8	8	81	64	64	7203.087	576	763.84	678.968	679
4	85.871	9	8	7	81	64	49	7373.829	504	772.84	686.968	601.1
5	86.871	14	15	16	196	225	256	7546.571	3360	1216.2	1303.065	1390
6	87.871	13	15	15	169	225	225	7721.313	2925	1142.3	1318.065	1318
7	88.871	12	12	12	144	144	144	7898.055	1728	1066.5	1066.452	1066
8	89.871	8	13	12	64	169	144	8076.797	1248	718.97	1168.323	1078
9	90.871	9	13	13	81	169	169	8257.539	1521	817.84	1181.323	1181
10	91.871	10	8	8	100	64	64	8440.281	640	918.71	734.968	735
11	92.871	12	12	12	144	144	144	8625.023	1728	1114.5	1114.452	1114
12	82.871	10	11	13	100	121	169	6867.603	1430	828.71	911.581	1077
13	83.871	12	12	12	144	144	144	7034.345	1728	1006.5	1006.452	1006
14	84.871	12	15	15	144	225	225	7203.087	2700	1018.5	1273.065	1273
15	85.871	9	10	10	81	100	100	7373.829	900	772.84	858.71	858.7
16	86.871	13	12	12	169	144	144	7546.571	1872	1129.3	1042.452	1042
17	87.871	12	13	13	144	169	169	7721.313	2028	1054.5	1142.323	1142
Σ	1478.8	191	204	202	2211	2540	2500	128791	29208	16594	17736.684	17564

So the Multiple Linear Regression equation which states the effect of the independent variable on the dependent variable in the aspect of time is:

$$Y = 94,186 - 0,367x_1 - 0,108x_2 - 1,014x_3 + 0,873x_4$$

So the Multiple Linear Regression equation which states the effect of the independent variable on the dependent variable in the cost aspect is:

$$Y = 87,009 - 0,0006x_5 - 0,001x_6 - 0,0002x_7$$

From the recapitulation table above and all calculations that have been done, it can be seen that all independent variables influence the dependent variable. The magnitude of the influence of each independent variable is different. The level of suitability of planning and project realization on the time aspect based on the secondary data discussed in chapter 4.3.1 is 87.5% while the level of the suitability of planning and realization on the time aspect is based on the calculation of multiple linear regression analysis is 76.38%. Meanwhile, the level of suitability of planning and project realization on the cost aspect based on secondary data discussed in chapter 4.3.1 is 87.8708%, while the level of suitability of planning and realization on the cost aspect based on the calculation of multiple linear regression analysis is 99.982%.

It should be noted that the total percentage of the level of conformity of planning and project realization in the time aspect discussed in this chapter when compared with the calculation of the percentage level of conformity with the planning and realization of the project in the time aspect discussed in chapter 4.3.1 can give different results due to the percentage of the total effect of the variable. The freebies discussed in this chapter only pay attention to the impact of the COVID-19 pandemic. So that the researchers did not discuss and calculate other factors that also occurred during the construction of the Soedono Madiun Hospital and allow changes to the level of suitability of planning and realization in the aspect of time as a dependent variable outside the impact of the COVID-19 pandemic, such as delays in the implementation of casting work due to weather, inaccuracy in ordering time, labor capability, equipment breakdown, labor productivity, equipment productivity, and so on in addition to the 4 independent variables (X1, X2, X3, and X4) that affect the time aspect and have been mentioned previously.

Meanwhile, it should also be noted that the total percentage of conformity level of planning and project realization on the cost aspect discussed in this chapter when compared with the calculation of the percentage level of conformity of the planning and project realization on the cost aspect discussed in chapter 4.3.1 may give different results because the percentage The total effect of the independent variables discussed in this chapter only considers the impact of the COVID-19 pandemic. So that the researchers did not discuss and calculate other factors that also occurred during the construction of the Soedono Madiun Hospital project and allow changes to the level of suitability of planning and realization on the cost aspect as a dependent variable outside the impact of the COVID-19 pandemic such as damage to materials in storage areas, shortage of equipment, , and so on in addition to the 3 independent variables (X5, X6, and X7) that affect the cost aspect and have been mentioned previously.

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4. Conclusion

Based on the results of research and data analysis that has been done, it can be concluded as follows :

1. The impact of the covid-19 pandemic on construction projects (A case study construction project RSUD Soedono Madiun) are all independent variables. In the time aspect, there is a change in the time schedule due to the physical distancing policy made by the government (X1), a change in the time schedule due to delays in the arrival of workers (X2), a change in the time schedule due to the delay in arrival of construction materials (X3), a change in the time schedule due to delay in the arrival of construction equipment (X4), while in the aspect of costs are a reduction in the budget provided by the government (X5), changes in costs due to instability in construction material prices (X6), changes in costs due to increases in construction equipment rental prices (X7). All of the independent variables that have been mentioned, both those that affect the time and cost aspects, affect the suitability of planning and project realization as the dependent variable (Y)
2. The biggest impact of the covid-19 pandemic that has the most influence on construction projects (A case study construction project RSUD Soedono Madiun) was obtained from the independent variable (X) which has the highest influence on the dependent variable on the time aspect is the independent variable X3, namely the change in time. on the time schedule due to the late arrival of construction materials of 1.014, while in the cost aspect is the independent variable X6, namely changes in costs due to the instability of construction material prices of 0.001. This was obtained through the process of multiple linear regression analysis of the distribution of questionnaires that have been answered by the parties directly involved in the construction project of RSUD Soedono Madiun

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Efficiency Analysis of Foundation System (Combined Bored Pile and Raft Foundation) Building Structure on Silt Clay Soil

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Abstract

The increasing number of residents in South Tangerang has an impact on increasing the need for lower housing. The development of vertical housing with the market name of flats, apartments and is the most effective anticipatory solution to overcome land prices which result in market limitations, especially for the upper middle class. This 32-storey apartment project uses a combined foundation system between drill pile foundation & raft foundation. With the combination of these two very massive systems, of course, it will have a very expensive cost to implement and take a long time to complete. In order to avoid cost overruns, the foundation design must look at the possibilities. To determine the efficiency of the combined system foundation design between pile bored foundation & raft foundation, the researchers analyzed the value of the bearing capacity and also the settlement that occurred in the existing foundation using the Poulos method, the equivalent Raft method and the Vesic method. From the results of the study, it was found that the contribution of the pile foundation bearing capacity was 24.10%. the placement of the raft foundation is 75.90% and the settlement analysis using the Poulos 8.95cm method, the 12.41cm Equivalent Raft method and the Vesic 12.1cm method, these three results are close to the maximum settlement limit.

Keywords:

Apartment, Bored Piles, Raft Foundation, Poulos Method, Equivalent Raft Method and Vesic Method.

1. Introduction

South Tangerang City is one of the important satellite cities of the capital city of Jakarta. The large number of people who support the activities of the City of Jakarta then have a new impact on Tangerang Regency and South Tangerang City. Apart from being the city where the country's main airport stands and as an industrial area, Tangerang Raya is also known as a rapidly growing residential area. The increase in population has become a complex and difficult problem to solve, especially in urban areas, especially in big cities in Indonesia, resulting in the need for land to continue to increase Wahyudi Wahyudi, Irwan Irwan, (2017). The development of vertical housing under the market name of flats, apartments and condominiums is the most effective anticipatory solution to overcome the high price of land which results in limited market share, especially for the lower middle class. The Canary Apartment is an integrated residential complex. The development includes a mixed-use concept that includes residential units, garden houses, and offices.

The Canary Apartment is a 32-floor apartment project. The project is located in Tangerang, Banten which is included in the low earthquake zone and is built on silty to medium clay soil where the hard soil elevation (N-SPT 50) is at a depth of > 50 m. The foundation system used in this building is a combination of bored piles and raft foundations. Bore pile foundation with a depth of 32 m and a raft foundation with a thickness of 2 m above which also functions as a pilecap. Where the combination of bore pile and raft foundation is located in the tower area of The Canary Apartment. Thus, The Canary Apartment tower is supported by a bore pile of 157 points which is quite a lot plus a raft foundation with a thickness of 2 m as a pilecap evenly distributed throughout the tower area.

With the combination of two very massive foundation systems, this will certainly have an impact on a very expensive cost to implement and a long time to complete Ali & Al-Kodmany, (2012), In addition, the condition of the building structure in the form of a 32-storey dwelling with a regular floor plan configuration and not located in an earthquake-prone zone still allows for efficiency of the massive foundation system as long as the settlement value is relatively safe. The focus of the author will be to review the combined foundation system by carrying out design efficiency, especially reducing the thickness of the raft foundation, which is no longer as thick as 2.0m or the number of piles and the depth of the pile used is not as deep as 33m. The review is carried out based on structural drawings, soil data and the existing foundation design report.

Based on the above review, in writing this final project the author uses the title:

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"Analysis of the Efficiency of the Foundation System (Combined Bored Pile and Raft Foundation) Building Structures on silty clay soil (Case Study of 32 Floor Apartment Development Projects in South Tangerang)".

2. Methodology

The research method used in this final project is quantitative method, field data and study from several literature studies.

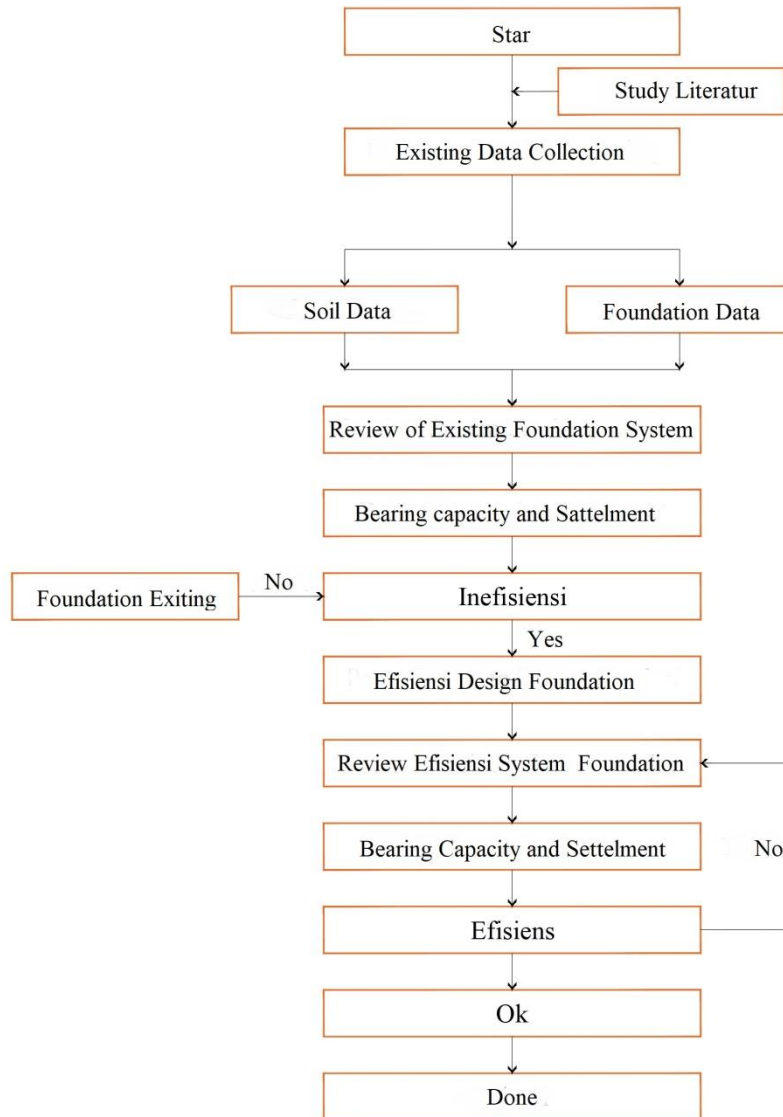


Figure 1. Flowchart
 Source : Processed Researcher

2.1. Object of Research

In this final project, the object of research is the 32-floor Canary Apartment Development Project in South Tangerang – Banten.

2.2. Method of Collecting Data

Soil parameter data which includes the Index Properties and Engineering Properties of the soil were obtained from field testing of 2 boring points and 6 sondir points at the project site and continued with laboratory testing where the results of the soil parameters were compiled in a soil investigation report for The Canary Apartment Development Project Susila, Endra, (2012).

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2.3. Soil Investigation Job

1. Sondir
2. Deep Drill
3. Standard Penetration Test (SPT)
4. Undisturbed soil sampling
5. Laboratory Testing

Soil samples that have been taken from the field are then tested in the laboratory with tests that are in accordance with the needs of foundation planning for the Apartment The Canary 2 project which will be located in BSD – South Tangerang, namely by determining the soil classification, its physical and technical properties. All tests are carried out according to ASTM testing standards.

Tests carried out include:

1. Determination of soil physical properties
2. Determination of water content: ASTM D 2216
3. Determination of Specific Gravity : ASTM D 854
4. Determination of Grain Size Distribution : ASTM D 422
5. Determination of Plastic and Liquid Limits : ASTM D 4318
6. Determination of soil engineering properties
7. Unconfined Test : ASTM D 2166
8. UU Triaxial Test : ASTM D 2850
9. CU Triaxial Test : ASTM D 4767
10. Consolidation Test : ASTM D 2435

2.4. Soil Condition in The Canary Apartment Project

The subsoil of the The Canary Apartment Project area was evaluated using the overall test results in the field with the location of the points as shown in the plan attached to this report and the overall results of the laboratory tests, which are described below.

Drilling results and sondir test results

Field testing at The Canary Apartment Project site in BSD, South Tangerang, only consisted of 2 drill data to a depth of about 50m and 6 sondir data. The ground level of the review area is based on both drill point data and the 6 sondir data, based on about 4.63m~6.75m above the road level and according to information it will be adjacent to the Parkland Avenue building, which was previously built.

During the soil investigation at the ground level elevation, the drill points BH01 and BH02 were +5,943m and 4,721m, respectively. From the two drill data, it is estimated that the stratification of the soil layer is relatively inconsistent, especially the presence of a dense silty clay layer and an interspersed layer of dense sand/sand which is found starting at a depth of 10m.

In general, the composition of the soil layer consists of a mixture of clay and silt and partly sandy to the end of drilling (50m) which varies in consistency with interspersed layers of dense sand/sand that are inconsistent in their presence. The silty clay layer around the top 10m is generally very soft to moderately stiff, partially stiff and very stiff with N-SPT values = 2-8 partially with N-SPT values = 9-19.

6 sondir test showed that the partially sandy silty clay layer around the top 10 m has a cone resistance value $q_c = 5 \text{ kg/cm}^2 \sim 25 \text{ kg/cm}^2$ with some reaching a conical resistance value, $q_c = 30 \text{ kg/cm}^2 \sim 65 \text{ kg/cm}^2$

The sondir test was stopped at a depth of about 8.8~12.8m, ie when the sondir cone reached the sand/sand soil layer, the first was reached with a cone resistance value, $q_c \geq 250 \text{ kg/cm}^2$. The thickness of this dense sand layer, which is inconsistent, as stated in the 1-1' cross section, cannot be accepted from the sondir test results. From the BH1 data, the silty clay layer from a depth of 16m to 32m was found to be generally stiff to very stiff with a value of N-SPT = 15-28 with some (at 22.5m) reaching N-SPT = 35 with a thickness of less than 1.5m. Meanwhile, based on BH2 data, the silty clay layer (partially sandy) at a depth of 16m~32m was found to be dense and very hard with N-SPT values > 30 .

So this shows that in addition to the inconsistent thickness of the intercalated sand/sand layer, the gray silty clay layer at a depth of 16~32m is also found to be quite inconsistent. The cemented silty clay layer at a depth of more than 33m is estimated to be in a consistent state, namely moderately dense/hard with a value of N-SPT = 37 ≥ 50 , some of which are estimated to be interspersed with a medium to dense layer of sand/sandy. 2 drill data at the location of The Canary Apartment Project shows a relatively inconsistent soil layer. So that the soil layer between the two drill points cannot be calibrated like BH-01 or BH-02. So for further planning it is recommended to add a drilling test.

Based on the geological map sheet of Jakarta and the Thousand Islands the stratification of the soil layers at the project site can generally be grouped into 2 formations (units), namely:

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The alluvium/alluvial (Qav) fan formation consisting of a Pumice Tuff layer and an alternation between a Tuff Layer and a Sandy Tuff layer

The Tile Formation (Tpg) consists of layers of Tufaan clay and Tufaan Sandstone Lenses.

In general, by comparing the results of field tests and geological maps, the stratification of the soil layers at the location of The Canary Apartment Project can be explained as follows:

UPPER STRATUM (CH/MH)

The soil layers, which are grouped as Upper Stratum at this project site, consist of a mixture of clay and silt with a red to reddish-brown color which is generally very soft to medium in consistency with some stiff to very stiff with an N-SPT value = 2-19 and resistance cone, $q_c = 5 \text{ kg/cm}^2 - 65 \text{ kg/cm}^2$.

This upper stratum is thought to be a Pumice Tuff layer from the Alluvium Fan formation. This upper stratum is found to a depth of about 9~10m.

CENTRAL STRATUM (SH/MH/CL/SP)

The silty/sandy clay layers and alternating sand layers are found from about 10m to 21m, grouped as alternating tuff layers with sandy tuff from alluvium peeled formations in this discussion. The sondir test generally stops when the sondir cone reaches the silty clay layer or the first dense sand layer is reached. The first layer of hard soil reached at this project site is relatively varied in thickness where at the bot point location BH-01 it is found to be around 5m, while at point BH-02 it is about 1m (cross section 1-1').

The consistency of the silty clay layer at the bot point location BH-01 varied from stiff to very stiff with N-SPT value = 15-21. Meanwhile, at the drill point location BH-02, a very stiff to dense layer of silty clay was found alternating with layers of medium to dense sand with a value of N-SPT = $25 \geq 40$.

LOWER STRATUM (CH/MH/CL/SP/SC/SM)

The soil layers found at a depth of more than 21m below the ground level at the bot-points BH-01 and BH-02 until the end of the drilling, were classified as lower stratum. The lower stratum generally consists of a layer of silty clay (partially sandy) of varying consistency. Up to a depth of about 32m the consistency of the silty clay layer is between very stiff to dense with an N-SPT value of 19-35 in BH-01, while at the BH-02 location it is generally solid with an N-SPT value of 40. Starting from a depth of about 32m until the end of drilling (~50m), the silty clay layer was found to be relatively more consistent in its presence, namely with a value of N-SPT = $37 \geq 40$ with some (inconsistent) inserted a relatively less dense layer of silty clay.

The stratification of the soil layer at this location can be estimated according to the value of N-SPT and cone resistance.

2.5. Pile-raft and Lowering Foundation Design

1. Pile-raft Foundation Design with Poulos Method

Geotechnical Parameter Study

The first thing that must be done after all the load data is obtained is to estimate the capacity of the pile-raft foundation system against the structural loads. The capacity of the pile-raft foundation system against vertical loads is calculated by adding up the ultimate capacity of the raft components with the total capacity of all piles in the system. The values used to calculate the bearing capacity of the raft and pile components were obtained from the correlation made by Decourt, (1995). The correlation is made on the basis of the N-SPT value.

a. Ultimate bearing capacity of raft components

$$p_{ur} = K1 N_r$$

wherein:

p_{ur} = The ultimate bearing capacity of the raft components (kPa)

N_r = N-SPT averaged over a depth of 1.5 times the width of the raft component (without units)

$K1$ = correlation factor for raft components (without units)

b. Ultimate bearing capacity of pile components

1) Pile's ultimate friction resistance

$$f_s = 2,8 N_s + 10$$

wherein:

f_s = Pile's ultimate friction resistance (kPa)

N_s = N-SPT average along the pile (without units)

2) Pile's ultimate end resistance

$$f_b = K2 N_b$$

wherein:

f_b = pile ultimate end resistance (kPa)

N_b = N-SPT near the end of the pole (without units)

$K2$ = correlation factor for pile components (without units)

2. Equivalent Raft Method

The efficiency of the combined foundation system (piles & raft foundation) / piled raft system in The Canary Apartment project is designed based on the equivalent raft method. This method was developed by Poulos, (1989) & Tomlinson, (1994) where the pile foundation in the piled raft system is converted into a slab foundation which is at $2/3 L$ of the top of pile.

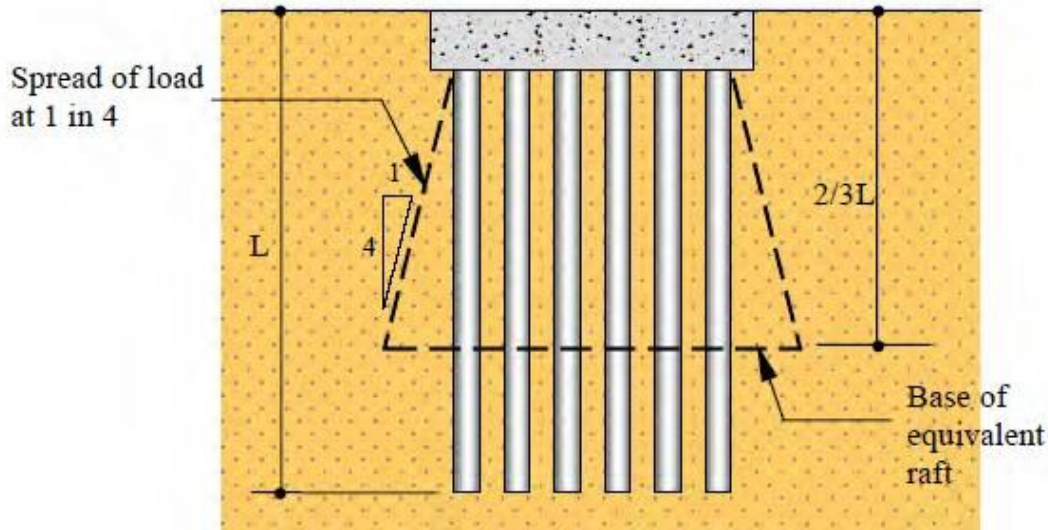


Figure2. Raft Equivalent Metode

3. Metode Vesic

In the calculation of the settlement of group piles are generally larger than single pile foundations, because of the influence of stress on a wider and deeper area. Using Vesic (1977) gives a simple formula as follows :

$$S_g = S \sqrt{\frac{B_g}{D}}$$

Where :

S_g = single pole settlement (m).

B_g = pile group width (m).

D = foundation dimensions (m).

3. Result and Discussion

3.1. Result

1. Project Structural Data and Existing Condition

The Canary Apartment project is a high-rise building project with 32 floors and 2 semi-basement floors located in South Tangerang – Banten. functioned as an apartment/residential.

a. Area Data, Building Functions.

- 1) Land Area : 2995,4 m²
- 2) Number of floors : 32 lantai, dengan 2 basement, 1 Mezanine dan 4 Lantai area komersil.
- 3) Building function
 - a. Built to meet residential needs in densely populated areas.
 - b. A total of 603 apartment units of various types and sizes.
 - c. All units are in a 25-story tower.
- a) Foundation Type : Combined Raft Foundation and Bore Pile
- b) Bored Pile Depth : 35 m
- c) Diameter : 80 cm
- d) Raft Thickness : 2 m
- e) Material Quality : $F'_c = 30 \text{ Mpa}$
 $F_y = 400 \text{ Mpa}$

The Canary Apartment project was built on soft to medium clay soil where the hard soil layer with $N > 50$ has not been found until the final drilling depth at an elevation of 50 m. The superstructure of the building is a

reinforced concrete building structure, beam column frame and shearwall. The lower structure of the building is in the form of a combined foundation system between bored pile piles and raft foundations.

2. Contribution to the Bearing Capacity of Raft Foundation and Pile Foundation

Raft Foundation Bearing Capacity (Without Piles Involving)

Raft Foundation Data :

Raft Thickness (rb) = 2 m

Raft Thickness (Pw) = 71.999 ton

Raft Length (Lr) = 60 m

Raft Width (Br) = 35 m

Raft Area (Ar) = 60 × 35 = 2100 m²

Calculation of the carrying capacity of the raft using the Meyerhof method (general bearing capacity):

Meyerhof . bearing capacity factor:

$$F_{cs} = 1 + \frac{B}{L} \times \frac{N_q}{N_c} = 1 + \frac{35}{60} \times \frac{1}{5.14} = 1,112$$

$$F_{cd} = 1 + 0.4 \times \frac{D_f}{B} = 1 + 0.4 \times \frac{2}{35} = 1,022$$

$$F = F_{qs} = F_{qd} = F_{qi} = F_{ys} = F_{yd} = F_{yi} = 1$$

Then the bearing capacity of the raft foundation:

$$q_u = c \times N_c \times F_{cs} \times F_{cd} \times F_{ci} + \gamma \times D_f \times N_q \times F_{qs} \times F_{qd} \times F_{qi} + \frac{1}{2} \times \gamma \times B \times N_\gamma \times F_{ys} \times F_{yd} \times F_{yi}$$

$$q_u = 75 \times 5,14 \times 1,112 \times 1,022 \times 6,69 + 2 \times 1 \times 1 \times 1 \times 1 \times 1 + \frac{1}{2} \times 6,69 \times 35 \times 1 \times 1 \times 1 \times 1$$

$$q_u = 305.001 \text{ ton/m}^2$$

Then the ultimate bearing capacity of the raft foundation:

$$Q_u = q_u \times A_r$$

$$= 305.001 \times 2135$$

$$= 640502.1 \text{ ton}$$

a. Pile Foundation Bearing Capacity (Without Involving Raft)

Pile bearing capacity (single pile & group pile) is taken from the foundation report.

Data Pondasi Bored Pile :

Number of poles (n) = 157 tiang

Pole size = Ø80 cm

Pole depth = 35 m

Safety Factor (SF) = 2,5

Efficiency factor (eff) = 0,9

1) Single pile bearing capacity (single pile)

$$\text{Pile group clearance } (Q_{all(s)}) = 576 \text{ ton}$$

$$\begin{aligned} \text{Single pile ultimate bearing capacity } (Q_{u(s)}) &= Q_{all(s)} \times SF \\ &= 576 \times 2,5 \\ &= 1440 \text{ ton} \end{aligned}$$

2) Bearing capacity of pile group (Group Pile)

- When treated as a single pole

$$\begin{aligned} \text{Pile group clearance } (g) &= n \times (s) \times eff \\ &= 157 \times 576 \times 0,9 \\ &= 81388.8 \text{ ton} \end{aligned}$$

- When treated as a pile group

$$\text{Pile group clearance } (Q_{all(g)}) = 81388.8 \text{ ton}$$

$$\begin{aligned} \text{Pile group ultimate bearing capacity } (Q_{u(g)}) &= n \times (s) \times eff \\ &= 157 \times 1440 \times 0,9 \\ &= 203472 \text{ ton} \end{aligned}$$

b. Comparison of Raft and Pile Bearing Capacity

From the above calculations, the results of the ultimate bearing capacity of each foundation are as follows :

$$\begin{aligned} Q_u \text{ Raft} &= 640502.1 \text{ ton} \\ Q_u \text{ Pile} &= 203472 \text{ ton} \\ (all) \text{ Sum} &= 640502.1 + 203472 \end{aligned}$$

$$= 843974.1 \text{ ton} > Q_u \text{ beban struktur atas (71999 ton)}$$

- Comparison of the percentage bearing capacity of raft and pile foundations

$$Q_{uall} \text{ Raft} = \frac{Q_u}{SF} = \frac{640502.1}{2.5} = 256200.84 \text{ ton}$$

$$Q_{uall} \text{ Pile} = \frac{Q_u}{SF} = \frac{203472}{2.5} = 81388.8 \text{ ton}$$

$$Q_{uall} \text{ Total} = 256200.84 + 81388.8 \\ = 337589.64 \text{ ton}$$

Then the percentage of bearing capacity borne by each foundation is :

$$\begin{aligned} \text{Raft Foundation} &= \left(\frac{Q_{uall} \text{ Raft}}{Q_{uall} \text{ Total}} \right) \times 100 \\ &= \left(\frac{256200.84}{337589.64} \right) \times 100 \\ &= 75.9 \% \end{aligned}$$

$$\begin{aligned} \text{Pile Foundation} &= \left(\frac{Q_{uall} \text{ Pile}}{Q_{uall} \text{ Total}} \right) \times 100 \\ &= \left(\frac{81388.8}{337589.64} \right) \times 100 \\ &= 24.1 \% \end{aligned}$$

From the calculation results above, the percentage of the carrying capacity of the boredpile foundation is 24.1% while the percentage of the raft foundation bearing capacity is 75.9%. The contribution to the bearing capacity of the raft foundation is greater than that of the bored pile foundation. In other words, the raft foundation plays a greater role in bearing the load from the superstructure in The Canary Apartment project compared to the pile foundation.

3. Pile Foundation System Efficiency

The efficiency of the combined foundation system (pile and raft foundation) / piled raft system in The Canary Apartment project is designed based on the Poulos method and the equivalent raft method

a. Metode Poulos

The capacity of the pile-raft foundation system against vertical loads is calculated by adding up the ultimate capacity of the raft components with the total capacity of all piles in the system. The values used to calculate the bearing capacity of the raft and pile components were obtained from the correlation made by Decourt, (1995). The correlation is made on the basis of the value of N-SPT.

b. Poulos Method Calculation

The manual calculation of the pile-raft foundation using the Poulos method is as follows:

Soil Properties

$$C_u = 75 \text{ Kpa} = 0,699 \text{ ton/ft}^2$$

$$\phi_u = 0$$

$$E_u = 52000 \text{ Kpa} = 484,64 \text{ ton/ft}^2$$

$$E' = 46800 \text{ Kpa} = 436,176 \text{ ton/ft}^2$$

$$\nu' = 0,35$$

$$\nu_s = 0,5$$

Raft Carrying Capacity

$$\text{Raft Thickness (rb)} = 2 \text{ m}$$

$$\text{Structure Load (P}_w) = 131,057 \text{ ton}$$

$$\text{Raft Length (L}_r) = 61 \text{ m} = 200.08 \text{ ft}$$

$$\text{Raft Width (B}_r) = 35 \text{ m} = 114.83 \text{ ft}$$

Raft's Ultimate Carrying Capacity (q_u)

$$q_u = 5,69 \times c_u$$

$$q_u = 5,69 \times 0,699 = 3,9773 \text{ ton/ft}^2$$

$$P_u = B^2 \times q_u$$

$$P_u = B \times L \times q_u$$

$$P_u = 114.83 \times 200.08 \times 3,977$$

$$P_u = 91372.316 \text{ ton} = 913.723 \text{ MN}$$

- **Ultimate Bearing Capacity of Mast Components**

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- Mast Ultimate Friction Resistance
 - Pile length = 35 m
 - Pile Dimension = 0,8 m
 - Pile Surface Area (A_p) = $4 \times \pi \times r^2 = 20.096 \text{ cm}^2$
- Tahanan friksi ultimit tiang (f_s)
 - $f_s = 2,8 \times N_s + 10$

Tabel 1 Calculation of the ultimate frictional resistance of pile components

Layer Thickness (m)	Ns	fs (kpa)	As (m)	Ps (N)	Ps (MN)
16	15	52	1,8	1497,6	1,4976
8	26	82,8	1,8	1192,32	1,19232
TOTAL Ps				2689,92	2,68992

- Pillar Ultimate End Resistance
 - $N_b = 26$
 - $K_2 = 100$
 - Pile's ultimate end resistance (f_b)
 - $f_b = K_2 \times N_b$
 - $f_b = 100 \times 26$
 - $f_b = 2600 \text{ Kpa}$
 - $P_b = f_b \times A_p$
 - $P_b = 2600 \times 0,2001$
 - $P_b = 520,26 \text{ Kpa} = 0,520 \text{ MN}$
 - $P_u = P_s + P_b$
 - $P_u = 2,69 + 0,52$
 - $P_u = 3,210 \text{ MN} = 321 \text{ ton}$

- **Pile Foundation's Ultimate Bearing Capacity**

$$P_u = P_{ur} + n_p \times (P_s + P_b)$$

$$P_{ur} = 913.723 \text{ MN}$$

$$P_s = 2,69 \text{ MN}$$

$$P_b = 0,520 \text{ MN}$$

- **Calculation of Foundation Stiffness**

$$c = \frac{L_r}{2} = \frac{61}{2} = 30.5$$

$$d = \frac{B_r}{2} = \frac{35}{2} = 17.5$$

$$\frac{d}{c} = \frac{17.5}{30.5} = 0.574$$

$$v = 0.2$$

1. **Rigidity of Assembled Components**

$$K_r = \frac{G_s}{(1 - v_s)} + \beta_z \sqrt{4cd}$$

The average soil shear modulus to the pile tip depth

$$G_s = \frac{E}{(2(1 + \mu))}$$

Tabel 2 Shear modulus calculation

Layer	μ	E (Mpa)	G_s (Mpa)
layer I (CH/MH)	0,5 (UD)	52	17,33
layer II (CH/MH)	0,5 (UD)	52	17,33
G_s Avg			17,33

Coefficients based on raft dimensions, c and d (β_z) = 2,1

Tabel 3 Calculation of bearing capacity and settlement using the Poulos method

No of piles	Pu	Pu	Pu	Kekakuan Grup Tiang (Kp-sys)	Kpr	α	βp	P	Pp	Pr	Pup	P1	CASE	Settlement (m)	Settlement (cm)
	(MN)	(KN)	(ton)	(MN/m)				(MN)	(MN)	(MN)	(MN)	(MN)			
1	168	167528	16753	158	168	-0,33	1,49	236	350	-115	3	2	P>P1	0,27	27,48
4	177	177177	17718	1036	336	-0,47	1,90	236	447	-212	13	7	P>P1	0,28	27,69
9	193	193259	19326	1553	505	-0,85	6,87	236	1620	-1385	29	4	P>P1	0,27	26,80
16	216	215774	21577	2071	673	-4,41	-0,29	236	-69	305	51	175	P>P1	0,33	32,83
25	245	244722	24472	2589	841	1,40	0,42	236	98	137	80	193	P>P1	0,28	27,74
36	280	280103	28010	3107	1009	0,60	0,62	236	147	89	116	186	P>P1	0,24	24,01
49	322	321916	32192	3625	1177	0,38	0,72	236	170	65	158	218	P>P1	0,20	20,50
66	370	370163	37016	4142	1346	0,28	0,78	236	184	52	206	264	P<P1	0,14	13,66
81	425	424842	42484	4660	1514	0,22	0,82	236	193	43	261	319	P<P1	0,13	12,73
100	486	485954	48595	5178	1682	0,18	0,84	236	199	37	322	381	P<P1	0,12	11,84
121	553	553498	55350	5696	1850	0,16	0,86	236	204	32	389	450	P<P1	0,11	11,01
157	627	627476	62748	6214	2018	0,14	0,88	236	207	28	463	526	P<P1	0,10	10,27

c. Metode Raft Ekuivalen

The efficiency of the combined foundation system (piles & raft foundation) / piled raft system in The Canary Apartment project is designed based on the equivalent raft method. This method was developed by Poulos (1993) & Tomlinson (1994) where the pile foundation in the piled raft system is converted into a slab foundation which is at $2/3$ L of the top of pile..

1) Equivalent Raft calculation method by comparison 1:4

- Raft dimensions
 - Raft Length (L) = 61 m
 - Raft Width (B) = 35 m
- Dimensions of the raft on $\frac{2}{3}$ pile length
 - Pile Length = 35 m
 - $\frac{2}{3}$ Pile Length = 23.3 m
 - Equivalent Raft Length (L') = 60 m
 - Equivalent Raft Width (B') = 35 m
 - Equivalent Raft Area = 2100 m
 - Raft Type Weight = 24 KN/ m³
 - Raft Thickness = 2 m
 - q Raft = 60 KN/ m³

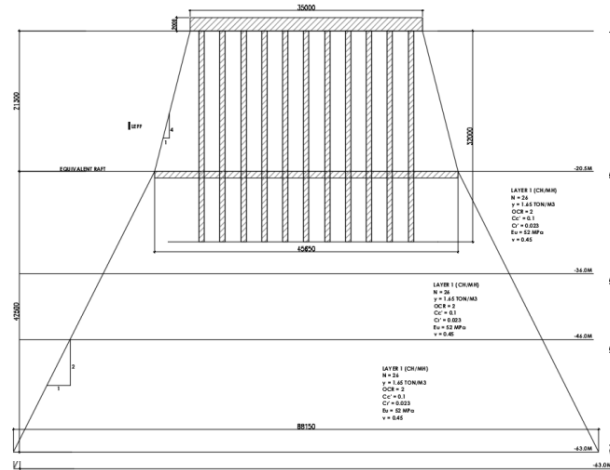


Figure 3. Pemodelan raft ekuivalen 1:4

Source : Processed Researcher

Calculation of settlement of the raft foundation system (pile-raft system) with the equivalent Raft method is as follows:

From the calculation results, the value of the decrease in each layer is as follows:

$$\begin{aligned} s_1 &= 5,413 \text{ cm} \\ s_2 &= 0,9265 \text{ cm} \\ s_3 &= 2,6276 \text{ cm} \end{aligned}$$

Then the total decrease value is:

$$\begin{aligned} s_{\text{total}} &= s_1 + s_2 + s_3 \\ &= 5,413 + 0,9265 + 2,6276 \\ &= 8,97 \text{ cm} \end{aligned}$$

2) Equivalent Raft calculation method by comparison 1:1

Raft dimensions

Raft Length (L) = 60 m

Raft Width (B) = 35 m

- Dimensions of the raft on $\frac{2}{3}$ pile length

Pile Length = 35 m

$\frac{2}{3}$ Pile Length = 23,3 m

Equivalent Raft Length (L') = 60 m

Equivalent Raft Width (B') = 35 m

Luas Raft Ekuivalen = 2100 m

Raft Type Weight = 24 KN/m3

Raft Thickness = 2 m

q Raft = 60 KN/m2

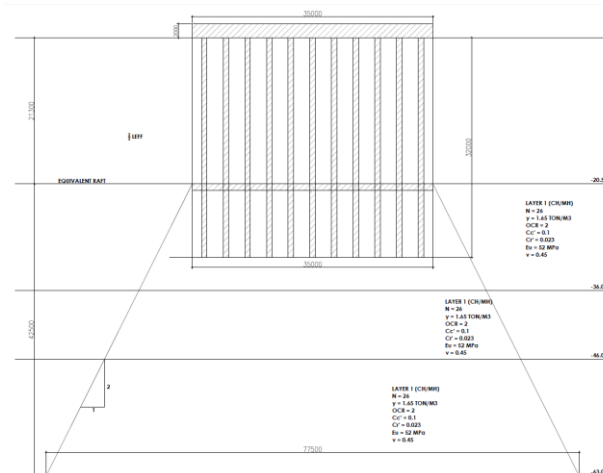


Figure 4. Pemodelan raft ekuivalen 1:1

Source : Processed Researcher

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Calculation of settlement (settlement) of the raft foundation system (pile-raft system) with the equivalent Raft method is as follows :

From the calculation results, the value of the decrease in each layer is as follows:

$$s_1 = 7,704 \text{ cm}$$

$$s_2 = 1,282 \text{ cm}$$

$$s_3 = 3,421 \text{ cm}$$

Then the total decrease value is:

$$s_{\text{total}} = s_1 + s_2 + s_3$$

$$= 7,704 + 1.282 + 3,421$$

$$= 12,41 \text{ cm}$$

d. Metode Vesic

1) Determining the Drop Along the Pile (S1) Based on the Boring Hole (BH-1), it is known that:

$$Q_p = 1.511.125 \text{ kg}$$

$$A_p = 0,5024 \text{ m}^2$$

$$Q_s = 288.955 \text{ kg}$$

$$E_p = 2625035395 \text{ kg/m}^2$$

$$\varepsilon = 0,5$$

$$L = 35 \text{ m}$$

Maka,

$$S_1 = \frac{(Q_p + \varepsilon \cdot Q_s) \cdot L}{A_p \cdot E_p}$$

$$S_1 = \frac{(1.511.125 + 0.5 \cdot 288.955) \cdot 35}{0.5024 \cdot 2625035395}$$

$$= 0.024 \text{ m} = 2.4 \text{ cm}$$

2) Determining Pile Depression Due to Load at the End of Pile (S2) Known :

$$C_p = 0,04$$

$$Q_p = 1.511.125 \text{ kg}$$

$$q_p = 1.925.000 \text{ kg/m}^2$$

$$D = 0.8 \text{ m}$$

Then,

$$S_2 = \frac{(C_p \cdot Q_p)}{D \cdot q_p}$$

$$S_2 = \frac{(0.04 \times 1511125)}{0.8 \times 1925000}$$

$$= 0.041 \text{ m} = 4.1 \text{ cm}$$

3) Determining Pile Lowering Due to Load Continued Along the Mast (S3) Is known:

$$Q_s = 288.955 \text{ kg}$$

$$D = 1 \text{ m}$$

$$p = 3,14 \text{ m}$$

$$E_s = 2.000.000 \text{ kg/m}^2$$

$$L = 35 \text{ m}$$

$$\mu = 0.4$$

$$I_{wp} = 2 + 0.35 \sqrt{\frac{L}{D}}$$

$$I_{wp} = 2 + 0.35 \sqrt{\frac{L}{D}}$$

Maka,

$$S_3 = \left(\frac{Q_s}{p \cdot L} \right) \frac{D}{E_s} \cdot (1 - \mu_s^2) \cdot I_{wp}$$

$$S_3 = \left(\frac{288955}{3.14 \times 35} \right) \frac{0.8}{200000} \cdot (1 - 0.4^2) \cdot 3,917$$

$$= 0.012$$

So the total drop of the pole (s) :

$$S = S_1 + S_2 + S_3$$

$$= 0,024 + 0,041 + 0,012 = 0,077 \text{ m}$$

4) Immediate Decline Group Pole Drop

In the calculation of the settlement of group piles are generally larger than single pile foundations, because of the influence of stress on a wider and deeper area. The settlement of pile foundations in cohesive soils is an

immediate settlement. The following is an example of calculating the settlement of a pile group with a diameter of 0.8m.

Is known :

$$S_g = 0,077 \text{ m} \quad B_g = 1.44 \text{ m} \quad D = 0,8 \text{ m}$$

Then,

$$S_g = S \sqrt{\frac{B_g}{D}}$$

$$S_g = 0.077 \sqrt{\frac{1.4}{0.8}} \\ = 0.121\text{m} = 12.1\text{cm}$$

3.2. Discussion

1. Percentage of Bearing Capacity

From the calculation results above, the percentage of pile foundation bearing capacity is 24.20% while the percentage of raft foundation bearing capacity is 75.80%. The contribution of the raft foundation bearing capacity is greater than that of the bored pile foundation. In other words, the raft foundation plays a greater role in bearing the load from the superstructure in The Canary Apartment project compared to the pile foundation.

2. Metode Poulos

Based on the results of calculations using the Poulos method, the settlement value of the existing foundation (number of piles: 157 piles) is 8.95 cm, which is smaller than the allowable settlement value of 15 cm. And it can be concluded that the foundation system can still be efficient by reducing the number of piles. The number of poles that can be used is 66 poles so that the maximum settlement value is obtained. The settlement value resulting from the efficiency calculation is 13.66 cm (less than 15 cm).

3. Metode Raft Ekuivalen

For the calculation of settlement (settlement) with the Raft Equivalent method is divided into 2, namely with a ratio of 1:4 and a ratio of 1:1. Based on the results of calculations using a 1:4 ratio, the decrease in value obtained is 8.97 cm, while by using a 1:1 ratio, the decline value obtained is 12.41 cm.

The value of the decrease in the results of the calculation of the Raft Equivalent method between calculations with a ratio of 1:4 with a calculation of 1:1 there is a difference in the results of the decrease. Where the calculation with a ratio of 1:1 gets a greater reduction than the calculation with a ratio of 1:4. This is because in the calculation with a ratio of 1:4 the distribution of the load distribution is wider so that the resulting decrease is smaller.

4. Metode Vesic

From the results of calculations using the Vesic method, the settlement value of the existing foundation (number of piles: 157 piles) is 12.1 cm smaller than the allowable settlement value of 15 cm. And it can be concluded that the foundation system can still be efficient but with very small efficiency because the decrease is almost close to the specified safe limit of 15cm (Badan Standarisasi Nasional., 2017).

5. Comparison of Poulos Method, Equivalent Raft Method & Vesic

Between the Poulos method, the equivalent raft method and the Vesic method, the resulting impairment values are different. Where the results of calculations using the Poulos method, the resulting decrease is smaller than the Raft Equivalent and Vesic methods. This is because the Poulos method does not take into account consolidation decline. While the equivalent raft method takes into account the consolidation calculations that occur.

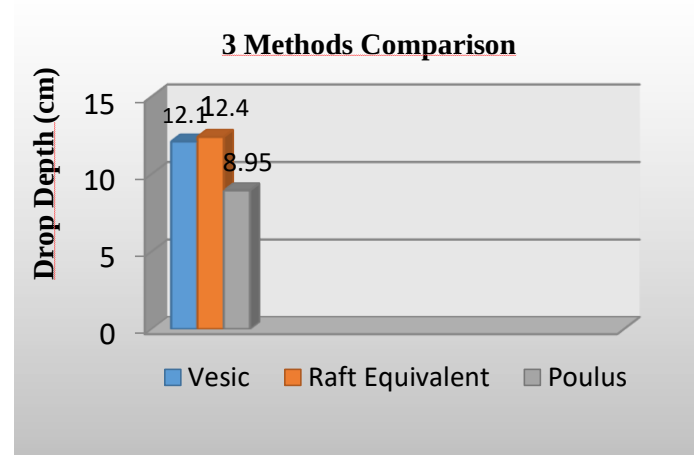


Figure1. Flowchart

Source : Processed Researcher

By using the Poulos method it is still possible to perform efficiency because in the existing foundation design the Settlement value is still far from the safe limit standardized in Indonesia..

4. Conclusion

Based on the results of the analysis on the combined system of raft and bored pile foundations, the following conclusions are drawn:

1. From the results of the analysis, it is known that the contribution of the bearing capacity of the raft foundation is greater than that of the bored pile. The percentage of the raft foundation bearing capacity is 75.90%, while the bored pile percentage is only 24.10%. This result is close to the requirements of the combined system design of the raft foundation and bored pile set in Badan Standarisasi Nasional., (2017) with a combination of 75% and 25%.
2. The design of the existing foundation in The Canary Apartment project with 157 piles with a depth of 35m and a raft of 2 m has met the requirements for carrying capacity and settlement. 8.95 cm then the equivalent raft method using a ratio of 1:1 the settlement value obtained is 12.41 cm and the last Vesic method is the settlement value on the existing foundation of 12.1cm. This result is smaller and has met the requirements of the maximum allowable total reduction limit of 15 cm (Badan Standarisasi Nasional., 2017).
3. In this case, the foundation system is deemed sufficient for efficiency, because the results of the three settlement analysis methods are close to the limit of the maximum allowable settlement. Efficiency can be done based on the Poulos method, which is where the decrease is still quite far from the specified safe limit or less than the total decrease allowed by Badan Standarisasi Nasional., (2017) which is 15 cm. However, this needs to be studied further because the calculation using the Poulos method does not take into account consolidation settlement and must pay attention to the requirements of the percentage contribution of the combined system of bored piles and raft foundations which are in (Badan Standarisasi Nasional., 2017).

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Biography / Biographies

Resi Aseanto is a lecturer from Mercubuana University Bekasi with civil engineering study Program and Director of Operations and Commercial PT Permata Graha Nusantara, a subsidiary of PGN.

Ali Ramdani Bagaskara is a student from Mercubuana University Bekasi with civil engineering study program. Prior to majoring in civil engineering, at the previous level, SMK Negeri 1 Sumedang, majoring in Building Drawing Engineering, penulis graduated from SMKN in 2016 in 2017 the author continued his education at Mercu Buana University Bekasi with a major in Civil Engineering. With this study the authors hope the research can be something of a learning and hope for further research can be well developed

Occupational Safety And Health Of Construction Projects In Dili, Timor Leste

(Case Study: Construction of ETO Tower Timor Leste, Construction of Dili Financial Business Center, Construction of New Office of Tribunal Distrital De Dili, Construction of Hospital Audian, Dili)

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Abstract

Occupational Safety and Health is the program to protect workers from the dangers of work accidents and occupational diseases that may occur during work. This study was conducted to determine the implementation performance of occupational safety and health program, to find out the obstacles during the implementation occupational safety and health programs, as well as labor laws and regulations relating to OSH on construction projects in Dili Timor Leste. This study collected data by distributing questionnaires to employees who work on the four (4) ongoing construction projects in Dili. Data analysis was carried out on Microsoft Excel which further processed the data using the mean count to determine the average value of the questionnaire and the standard deviation. This study found that the project in Dili has implemented the Occupational Safety and Health program. This can be seen from the overall results of the analysis with a mean value of 4.49 and a standard deviation of 0.473. From these results, it can be concluded that every construction project company prioritizes the implementation of OHS. The second result is the obstacles in applying OHS; from the analysis results show that the barriers from the worker side are rank 1 with a mean value of 2.90 and a standard deviation of 0.925. It can be concluded that many obstacles in implementing the OSH program occur from the workers' side due to the lack of awareness and knowledge of workers about OSH in working on construction projects. The result of the third analysis is Timor Leste's labor laws and regulations. The results of the analysis show that it is sufficient for companies to apply Law no. 4/2012 on employment in the areas of security, hygiene and health in the workplace.

Keywords:

Mean, PPE, Occupational safety and health, obstacles, OHS

1. Introduction

Dili is the capital of Timor Leste. This city is also a center for government, security, social, economic, business and industrial which has various facilities and infrastructure to support life. Timor Leste as a small country located in the Asia Pacific and just obtained its sovereignty in 2002. As a new country, it is very important to develop the country's economy. This can be seen from various areas in Dili, the number of ongoing construction projects such as the implementation of government office buildings, hotel and apartment building construction, port construction, highway construction, and the implementation of other constructions.

The process of building a construction project is generally an activity that contains many elements of danger. This causes the construction industry to have a poor record in terms of occupational safety and health. Therefore, occupational safety is an aspect that must be addressed at any time because the problem of occupational safety and health is a very complex problem which includes problems in terms of humanity, economic costs and benefits, legal aspects, accountability and the image of an organization itself (Ervianto 2015).

The implementation of occupational safety and health in construction projects is a form of effort to create a safer, healthier, and more prosperous work environment, free from work accidents and diseases due to hard work and free from environmental pollution towards increasing productivity.

In the last ten (10) years (2010-2020), there have been quite a number of accidents occurring at work on construction projects in Dili. Based on data from the "Inspesun Geral ba Trabalho (IGT)" or general labor inspection, there were 21 cases and 17 of them died.

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From the problems above, in this research, the author tries to conduct a study of occupational safety and health on construction projects in Dili to find out how the implementation of occupational safety and health programs in this city. The method used by the author in collecting data is by distributing questionnaires to several construction project workers and direct observation in the projects. The results obtained from the questionnaire are then analyzed and then conclusions will be drawn regarding the obstacles in implementing the occupational safety and health program on construction projects in Dili, Timor Leste (Erni Kurniawati 2018).

2. Methodology

This research was conducted to find out how the implementation of the OSH program in Dili. Data collection methods were consisted of questionnaires and direct observation to construction projects. The data processing method in this study consists of an editing process to improve the quality of data obtained from questionnaires, entering, and analyzing. The data analysis method used to calculate the results of the questionnaire distribution is to use several formulas to calculate the mean value to find the average value and calculate the standard deviation.

3. Result and Discussion

In this study, the problem discussed is how to apply the occupational safety and health management system in Timor Leste. Data collection was carried out on 4 (four) major ongoing projects in the city of Dili. The method used is the distribution of questionnaires and direct observation to the construction site. The number of questionnaires distributed was 40 questionnaires and the respondents involved were workers who worked in construction sites (Soares and Amaral 2019).

3.1 Projects Data

The distribution of the questionnaires was carried out on ongoing construction projects in Dili. Classification of project data is carried out based on the type of the building, the number of floors of the building, and the project owner.

Tabel 1 Projects Data

No.	Building Type	N	Percentage (%)
1	Oficce	3	75
2	Apartement	0	0
4	Hotel	0	0
5	Shopping Center	0	0
6	Others	1	25
	Total	4	100
No.	Number of Floors	N	Percentage (%)
1.	Basement		
	0 – 2 Floor	4	100
	3 – 5 Floor	0	0
	Total	4	100
2.	Superstructure		
	1 – 5 Floor	2	50
	6 – 10 Floor	1	25
	11 – 20 Floor	1	25
	Total	4	100
No.	Project Owner	N	Percentage (%)
1.	Government	1	25
2.	Private	3	75
3.	Others	0	0
	Total	4	100

Table 1 shows that generally the type of buildings built in Dili are more in office buildings with a total of 3 (three) units of construction buildings. The number of building floors in construction projects in Dili, the highest value for the basement is 0 – 2 floors with a total of 2 buildings. For the highest value in the superstructure, 2 buildings are obtained, namely from floors 1 – 5 and floors from 6 – 20, obtained 2 buildings. The owner of the building project built in Dili is owned by a private construction service with a total of 3 projects and 1 project built with government construction services.

3.2 Respondent Data

In this research, the respondents involved are workers who work in construction sites. The workers in question are from project managers to builders. The reason for choosing these respondents are that based on the existing questionnaire, it includes questions from the management side and the workers side. Respondents were classified based on their name, age, last education level, position in the project and work experience. These factors are considered to have a considerable influence in the implementation of construction projects.

Tabel 2 Respondent Data

No.	Age	N	Percentage (%)
1.	≤ 25	12	30%
2.	26 – 35	13	32,5%
3.	36 – 45	12	30%
4.	≥ 46	3	7,5%
	Total	40	100%
No	Last Education	N	Percentage (%)
1.	Primary School	4	10
2.	Junior High School	11	27,5
3.	Senior High School	16	40
4.	Diploma	4	10
5.	Bachelor	5	12,5
6.	Others	0	0
	Total	40	100
No.	Position	N	Percentage (%)
1.	Site engineer	4	10
2.	Safety officer	5	12,5
3.	Foremen and other Staffs	13	32,5
4.	Workers	18	45
	Total	40	100
No.	Work Experience	N	Percentage (%)
1.	≤ 3 Years	16	40
2.	4 - 6 Years	13	32,5
3.	7 - 9 Years	2	5
4.	≥ 10 Years	9	22,5
	Total	40	100

Table 2 shows that generally construction workers in Dili from the 4 projects visited were mostly aged from 26-35 years old with a percentage of 32.5% and respondents aged 46 years had a low percentage of 7.5% or 3 person. Characteristics of respondents based on the latest education of workers on construction projects are generally high school graduates with a percentage of 40% or as many as 16 people, and respondents with the last education level of Bachelor are 5 people with a percentage of 12.5%. The classification of respondents based on the position in the project, namely handyman (worker) has the highest number with 45% or as many as 18 people, and the lowest rank is owned by respondents with positions as site engineer, which is 10% or as many as 4 people. Classification of Respondents Based on Work Experience of less than 3 years (≤ 3 years) has the first rank of 16 people. Respondents with 7 to 9 years of work experience with a percentage of 5% had the lowest number, which was only 2 people.

3.3 Identifying the Implementation of Occupational Health and Safety Program

In identifying the implementation of the OSH program, it includes workplace safety in the project, work equipment and clothing (PPE), fire, protection of the public, occupational and general health. The results of this classification can be seen in table 3.3 as follows:

Table 3 Results of the Analysis of the Occupational Safety and Health Program

No.	Occupational Safety and Health Program	Mean	SD	Rank
1.	Workplace Safety in Projects	4,68	0,440	1
2.	Equipment and Work Clothes (PPE)	4,68	0,440	1
3.	Fire	4,43	0,481	3
4.	Protection of The Public	4,54	0,554	2
5.	Occupational Health	4,36	0,534	4
6.	General	4,24	0,496	5
	Σ Mean	4,49		
	Σ SD		0,473	

Table 3 analysis results show that the occupational safety and health program in the 4 projects visited has an average value of 4.49 and a standard deviation of 0.473. From these results, workplace safety in the project and equipment and work clothes has rank 1 or the first rank with a mean value of 4.68 and a standard deviation of 0.440. This shows that each project site has good lighting and lighting, safety fences and open spaces have been installed in the project to prevent the fall of workers, and equipment and work clothes have been provided by the construction service company and are used properly by the workers.

3.4 Identifying Obstacles in Implementing Occupational Safety and Health

In identifying Obstacles in Implementing Occupational Safety and Health include barriers from the worker side and obstacles from the company side. The results of this classification can be seen in table 4 as follows:

Table 4 Results of Obstacle Analysis in Implementing Occupational Safety and Health

No.	Obstacles in implementing Occupational Safety and Health	Mean	SD	Rank
1.	Barriers From The Workers Side	2,90	0,925	1
2.	Brriers From The Company Side	2,25	0,881	2
	Σ Mean	2,57		
	Σ SD		0.903	

Table 4 analysis results show that the constraints in implementing occupational safety and health have a total mean value of 2.57 and a standard deviation of 0.903. From these results, labor barriers have the first rank in the construction project in Dili with an average value of 2.90 and a standard deviation of 0.925. This shows that limited knowledge about work safety makes workers reluctant to work with personal protective equipment and many workers do not know the guarantees on existing construction projects.

3.5 Timor Leste Labour Laws (Lei Trabalho No.4/2012) Concerning Safety, Hygiene and Health in the Workplace.

In identifying Timor Leste's Labour Laws (Lei Trabalho No.4/2012) concerning Security, Hygiene and Health in the Workplace, it includes general Requirements, general obligations of employer and general obligations of workers. The results of this classification can be seen in table 5 as follows:

Table 5 Results of Analysis of Timor Leste's General Employment Laws and Regulations (Lei Trabalho No. 4/2012 Concerning Safety, Hygiene and Health in the Workplace

No.	Timor Leste Labour Laws (Lei Trabalho No.4/2012) Concerning Safety, Hygiene and Health in the Workplace.	Mean	SD	Rank
1.	General Requirements	4,68	0,474	1
2.	General Obligations of Employers	4,61	0,493	2
3.	General Obligations of Workers	4,58	0,483	3
	Σ Mean	4,62		
	Σ SD		0,483	

Table 5 results of the analysis show that Timor Leste Labour Laws (Lei Trabalho No.4/2012) Concerning Safety, Hygiene and Health in the Workplace has a total mean value of 4.62 and a standard deviation of 0.483. From these results indicate that the companies comply with the law both from the company and workers

3.6 Result Of Field Observations

The results of the field observations on occupational safety and health in the 4 (four) projects visited have been running well. In the construction project, the workers are required to use the PPE attribute in order to avoid unwanted events.

It can be seen that the workers wear personal protective equipment (PPE) correctly but some do not wear personal protective equipment (PPE) while at the construction site. Based on interviews with the HSE team, there were workers who did not comply with the regulations and were difficult to reprimand.

Based on the observations in these 4 (four) projects, occupational health and safety such as workplace security, protection of the public and occupational health and others have followed the existing OHS regulations.

4. Conclusion

Based on the results of the analysis and discussion of the data, the authors obtain conclusions that can be drawn from research on Occupational Safety and Health in Dili Timor Leste with Case Study Construction of ETO Tower Timor Leste, Construction of Dili Financial Business Center, Construction of New Office of Tribunal Distrital De Dili, Construction of Hospital Audian, Dili as follows:

1. Based on the results of the analysis on the data, it shows that companies or construction workers simply apply Law no. 4/2012 concerning employment in the security, hygiene and health divisions in the workplace.
2. Based on the results of the analysis of the implementation of the Occupational Safety and Health program on construction projects in Dili, it was found that the occupational safety and health implementation program that took place in Dili City prioritized occupational safety and health programs. This can be seen from the overall results of the analysis with a mean value of 4.49 and a standard deviation of 0.473. From these results, it can be concluded that every construction project company prioritizes the application of as workplace safety in the project, work equipment and clothing, fire, protection of the public, occupational health and the general public.
3. Based on the results of the analysis of the constraints in implementing the occupational safety and health program, it was found that in identifying the Obstacles in Implementing Occupational Safety and Health included barriers from the worker side and barriers from the company side. From the results of the analysis on the data, it shows that the barriers from the worker side are rank 1 or rank first with a mean value of 2.90 and a standard deviation of 0.925. It can be concluded that many obstacles in implementing occupational safety and health programs occur from the workers' side due to the lack of awareness and knowledge of workers about in working on construction projects and many workers who do not know the guarantees on existing construction projects. Another thing that becomes an obstacle from the workers' side from the results of the analysis and direct observations in the field is that workers do not comply with K3 regulations such as not using PPE when working at construction sites and being difficult to be reprimanded by the HSE team.

5. Suggestions

Based on the conclusions above, the suggestions that the author can give are as follows:

1. Workers who work in construction sites are generally difficult to reprimand if they do not comply with the OHS regulations for example not wearing PPE, therefore the government is advised to emphasize OHS regulations, especially strong sanctions to workers in order to avoid work accidents.

2. For the government, especially in the SEFOPE section or general labor inspection, it is recommended to conduct OHS training so that workers who work in construction sites can better understand occupational safety and health regulations in the workplace.

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Biography

Maria Madalena De Jesus Soares was born in Dili, Timor Leste on March 20, 1995. In 2006 the author graduated from SD Negeri no.04. Fatuhada Dili, 2009 graduated from SMP Negeri 30 Comoro Dili, in 2013 graduated from SMA 05 Negeri 05 Maio Becora Dili. In 2017 the author was accepted as a student with the Civil Engineering study program at Narotama University Surabaya, Indonesia through an international scholarship. In 2021 Praise God will lead the author to get a Bachelor's degree in Civil Engineering.

Analysis about Planning and Modification of the Upper and Lower Structures of the 38 Floor Apartment SkyHouse Project with Equivalent Static Analysis

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Abstract

The modeled building structure is a regular building, with the number of levels being varied. The structural model is divided into 38-level portals. This research uses the help of the SAP2000 v21 program to facilitate the earthquake analysis process. The results of the study that will be compared are displacements between levels and base shear that occur due to earthquake forces. The results of the analysis have shown that static analysis produces greater results for the structural models compared to dynamic analysis. The difference in displacement between levels produced by the two methods in the three structural models is still included in the displacement limits between levels of permission required in B. & Wungo, (2012), so that the three models can still be analyzed by static analysis and dynamic analysis. Because the results of displacement and base shear in static analysis are greater than dynamic analysis, static analysis is safer if used for earthquake force loading in general structural calculations. Although in earthquake analysis, dynamic analysis is a more accurate analysis because the analysis process is closer to the actual situation.

Keywords:

Dynamic Analysis ,Static Analysis, SAP2000 v2, SNI 1726-2012.

1. Introduction

Indonesia is the fourth most populous country in the world with a population of around 269.6 million or 6% of the world's population. The large number of people in Indonesia causes the need for housing to increase. Therefore, there is a need for housing that does not require large land but can be used by many people, namely by the presence of high-rise buildings such as apartments.

The growth of apartments in Indonesia is increasing rapidly, the high demand for apartments in Indonesia is also due to land prices that are increasing from time to time. And this is in line with the increasing demand for housing for business people and professionals in the Alam Sutera areas. The type of housing chosen by the developer is an apartment with a residential concept that is in harmony with these conditions and is driven by regional conditions that can access entertainment centers, educational facilities and freeway facilities.

In planning this final project, it will focus on the discussion related to the comparison of the analysis of the modification of the upper and lower structures with earthquake static analysis in the planning of apartment buildings in the Alam Sutera area. This building has a 38-story building concept which must be taken into account against the loads acting on the building. The right method in analyzing earthquake loads, as well as planning shear walls that are able to withstand very large lateral forces and take into account the maximum forces that occur in structural elements both Columns, Shearwalls, Beams and Plates.

This study aims to compare the forces in the ultimate with the forces in the design and to determine whether the dimensions of the installed cross-section are able to withstand the forces in the ultimate due to the effects of external loading. Image of the structure of the SkyHouse AlamSutera Apartment project. Loading analysis refers to PBI 1983, and earthquake analysis uses equivalent static analysis method. Static analysis commonly used is the equivalent lateral force analysis. Dynamic analysis can be divided into two, namely analysis of variance response spectrum and analysis of seismic response history (time-history). Based on B. & Wungo, (2012), there are many limitations given in the static equivalent analysis procedure. This limitation is made because the results of the equivalent static analysis are less precise for various types of structures being built. Therefore, dynamic analysis is needed to obtain a building response that is closer to the actual structure response when an earthquake occurs. The results of the calculation of the structure of both plates, beams, and columns show that the value of the design bending moment (M_r) is greater than the ultimate bending moment (M_u).

Determination of the lower structure system must be based on the following data:

1. Architectural plans including the required number of basement layers.

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2. The condition and situation of the surrounding buildings.
3. Results of soil investigations which include:
4. Ground water conditions.
5. Research pumping test if the basement bottom is below ground water mica.
6. The layer of soil supporting the building foundation.
7. Recommendations for the foundation system along with the carrying capacity and estimated settlement of the building.

The shape of the building and the structural system of the building frame are closely related to each other both horizontally and vertically. A structural system is called good. Several things that must be considered in determining the structural system against lateral loads include:

1. Diaphragm stiffness and structural rigidity
2. Force distribution and resistance concentration
3. Resistance on the outer perimeter (perimeter) of the building structure
4. Vertical plane jump (vertical setback)
5. Structural irregularity
6. There is a large torque without sufficient resistance to accommodate the torque
7. Short column effect
8. Discontinuity of structural strength and stiffness due to transfer girders, transfer floors or structural walls that are not continuous downwards, and structural walls that are located alternating both in the vertical and horizontal directions.

The concept of selecting a structural system and the concept of planning/designing the structure of the building, such as the configuration of the floor plan and the loading that has been adjusted to the basic requirements for planning a high-rise building that applies in Indonesia so that it is hoped that the results that will be obtained will not cause structural failure.

2. Research Methodology

In making an analysis, data is needed as a reference material. To be able to perform a good analysis, data that includes information and basic concepts related to the object to be analyzed is needed. The data can be classified into two types of data, namely primary data and secondary data..

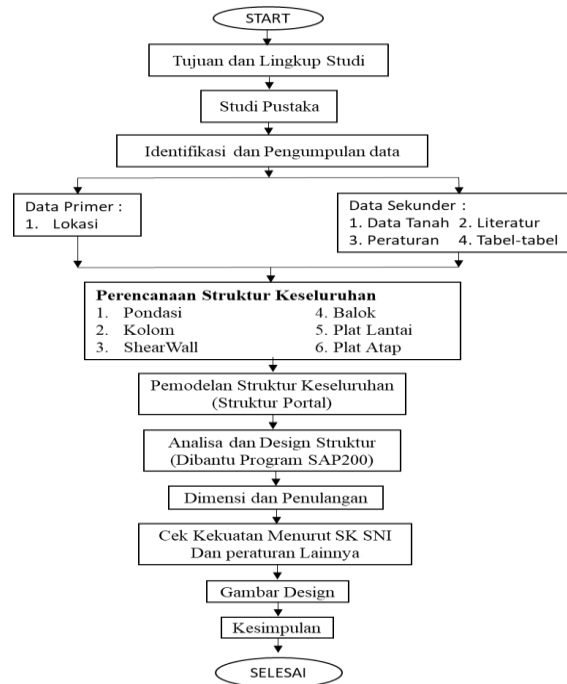
Primary Data is data obtained from the field or survey results that can be directly used as a source in structural analysis. Material specification data is used to determine the characteristics of the materials used in the structure. Namely as follows:

- a) Slab : $f'_c = 35 \text{ MPa}$
- b) Beam : $f'_c = 35/40 \text{ MPa}$
- c) Column : $f'_c = 35/40/45/50 \text{ MPa}$
- d) Foundation : $f'_c = 50 \text{ MPa}$
- e) Reinforcement : $f_y = 400 \text{ MPa}$, for main reinforcement
 $f_y = 240 \text{ MPa}$, for stirrup reinforcement
 $f_y = 520 \text{ MPa}$, for strand reinforcement and PC-wire

Land Data Soil data obtained from the results of investigations and soil testing in the laboratory, consisting of :

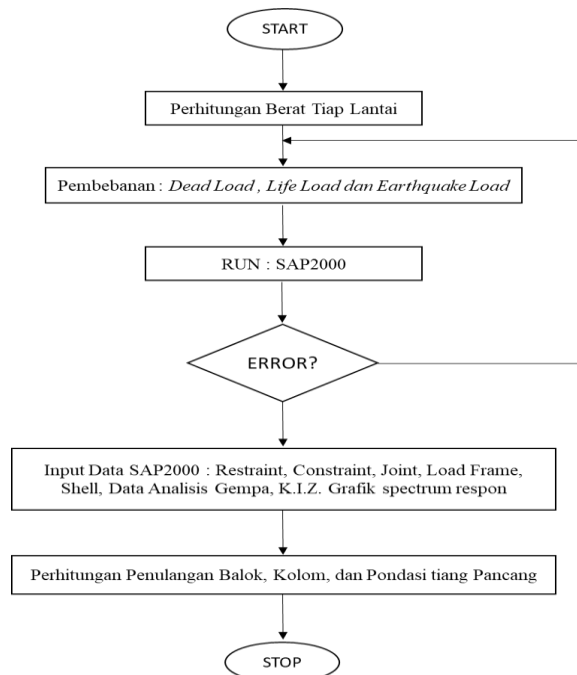
1. Boring
2. Direct Shear Test
3. Liquid Plastic Limit Test
4. Sondir
5. Grain Size Accumulation Curve

Figure 1. Final Project Compilation Flowchart



When modeling SAP 2000, the column elements will be released which will cause the moment in the bottom column to be 0. This is done because the connection between the precast columns is not pure clamping so that the modeling in SAP 2000 is expected to be close to the actual behavior in the field. But for connection analysis is based on P axial column tension (derived from the moment when the connection is purely clamped) and shear. With the help of this computer program, the program output will be obtained in the form of internal forces acting on the structure due to all existing load combinations including earthquake loads. The flowchart for portal mechanics calculations using SAP 2000 :

Figure 2. SAP2000 Analysis Compilation Flowchart

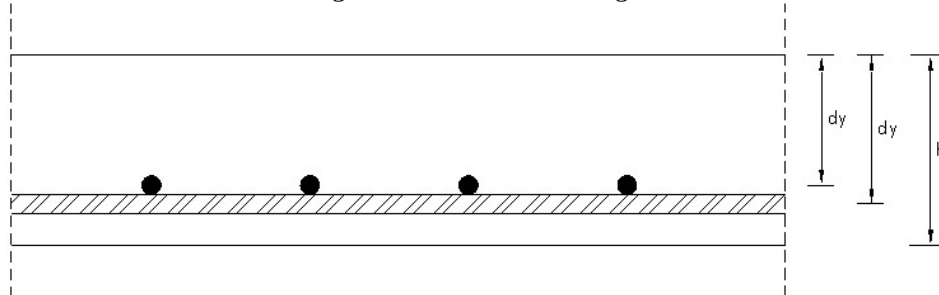


2.1. Slab Planning

Slabs are reinforced concrete panels which may be reinforced in two or one direction depending on the structural system. If in the slab structure the ratio of long span to short span is 3, it will experience deflection in both axes directions. The slab load is carried in both directions by the four supporting beams around the slab panels, thus the slab becomes a slab that flexes in both directions. The slab planning steps are :

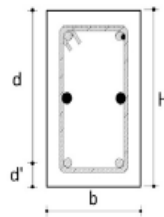
- Determine boundary conditions, supports and span lengths.
- Determine the working loads
- Determine plate thickness

Figure 3. Plate Effective Height



2.2. Beam Planning

In the pre-designed beam height according to (SNI 03-2847-2002, n.d.) is the function and span and quality of the concrete used. In general, the pre-designed beam height is $L/10 - L/15$, and the beam width is taken as $1/2H - 2/3H$ where H is the beam height. Calculation of internal forces on the beam using Avizan & Koespiadi, (2020) software. From the results of the output of these internal forces, they are then used to calculate the reinforcement requirements.



$$d' = p + \emptyset \text{stirrup} + \frac{1}{2} \emptyset \text{ main reinforcement}$$

$$d = h - (p + \emptyset \text{stirrup} + \frac{1}{2} \emptyset \text{ main reinforcement})$$

Figure .4. Plate Effective Height

2.3. Coloumn Planning

Column elements receive bending loads and axial loads, according to (SNI 03-2847-2002, n.d.) article 11.3.2.2. for planning columns that receive bending and axial loads, the material reduction coefficient is set at 0.65, while the distribution of reinforcement in columns (rectangular cross-section) can be done by installing symmetrical reinforcement on two sides of the column (two faces) or installing reinforcement on four sides of the column (four faces).

In planning this apartment building, column planning is used using reinforcement on four sides of the column cross section (four faces). Calculation of internal forces on the column using the Avizan & Koespiadi, (2020) program.

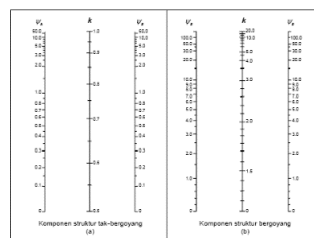


Figure 5. Effective Length Factor (k)

3. Result And Analysis

The results and discussion contain the following descriptions:

3.1. Structure Data

The building characteristics data are as follows:

- 38-storey apartment building with a total height of 118.5 m
- The height of the basement floor and 1st floor is 4.5 m which is used for parking, the height of the 2nd and 3rd floors is 3 m which is used as a commercial area and the height of the 3rd to 37th floors is 3 m which is functioned as a residence.
- The main structure is planned to use the Special Moment Bearing Frame System with the construction of Shearwall, Columns and Beams using reinforced concrete structures, floor plates and roof plates using reinforced concrete slabs.

Figure 6. 3D Building Structure System

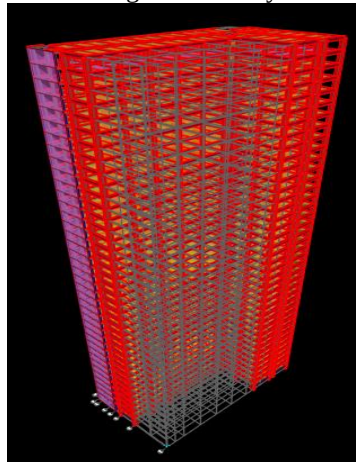


Figure 7. Layout Lt. 1 – 3

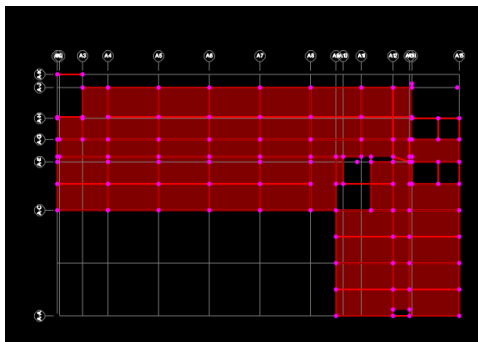


Figure 8. Layout Lt. 4

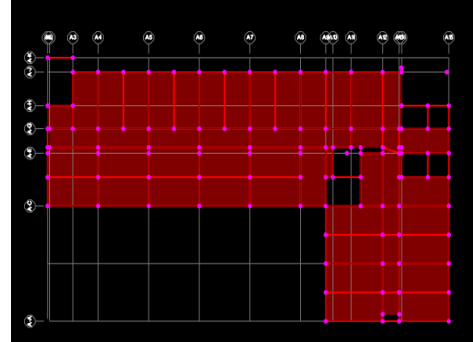


Figure 9. Layout Lt. 5 – 38

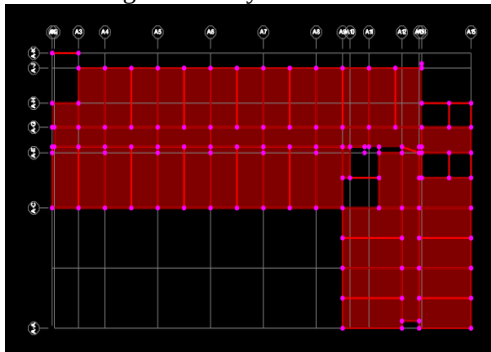


Figure. 10. Layout Lt. Roof

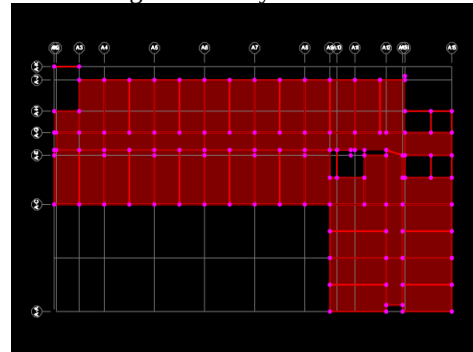


Table 1. Columns and ShearWall

Floor	TYPE COLOUMN (mm)								F'C (Mpa)
	C5	C8	C9	C10	C11	C11A	C11B	C12	
-1F	1200x700	1000x700	1200x600	1200x600	1200x600	1000x900	1100x800	1300x600	50
1F - 2F	1200x700	1000x700	1200x600	1200x600	1200x600	1000x900	1100x800	1300x600	50
3F - 1C/4F	1200x600	1000x700	1200x600	1200x600	1200x600	1000x800	1100x800	1300x600	50
5F	1200x600	1000x700	1200x600	1200x600	1200x600	1000x700	1100x700	1300x600	50
6F - 7F	1200x600	1000x600	1100x600	1200x600	1100x600	1000x700	1100x700	1200x500	50
8F - 11F	1200x600	1000x600	1100x600	1200x600	1100x600	1000x700	1100x600	1200x500	45
12F - 13F	1200x500	1000x500	1000x600	1100x600	1000x600	1000x600	1100x600	1200x500	45
14F - 18F	1200x500	1000x500	1000x600	1100x600	1000x500	1000x600	1100x600	1200x500	40
19F	1200x500	1000x400	900x600	1100x600	1000x500	1000x500	1100x500	1200x500	40
20F - 23F	1200x500	1000x400	900x600	1100x600	1000x400	1000x500	1100x500	1200x500	35
24F - 29F	1100x500	1000x400	900x500	1000x600	1000x400	1000x400	1000x500	1100x500	35
30F - 38F	1100x500	1000x400	900x400	1000x600	900x400	1000x400	1000x400	1100x500	35

Floor	TYPE COLOUMN (mm)							F'C (Mpa)	
	C1	C1A	C1B	C2	C2A	C3	C4		C4A
-1F	1200x600	1300x600	1200x600	1200x600	1200x500	1300x600	1200x700	1200x600	50
1F - 2F	1200x600	1300x600	1200x600	1200x600	1100x500	1200x600	1200x700	1200x600	50
3F - 1C/4F	1200x600	1200x600	1100x600	1100x600	1100x500	1200x600	1200x600	1200x600	50
5F	1100x600	1200x600	1100x600	1100x600	1100x500	1200x600	1200x600	1200x600	50
6F - 7F	1100x600	1200x600	1100x600	1100x600	1100x500	1200x500	1100x600	1100x600	45
8F - 11F	1000x600	1200x600	1100x600	1100x600	1100x500	1200x500	1100x600	1100x600	45
12F - 13F	1000x600	1100x600	1000x600	1000x600	1000x500	1100x500	1000x600	1000x600	40
14F - 18F	1000x600	1100x600	1000x600	1000x600	1000x500	1100x500	1000x600	1000x600	40
19F	1000x500	1100x500	1000x500	1000x500	1000x500	1100x500	1000x500	1000x500	35
20F - 23F	1000x400	1000x500	1000x500	1000x500	1000x500	1000x500	1000x500	1000x500	35
24F - 29F	1000x400	1000x500	1000x400	1000x400	1000x400	1000x400	1000x400	1000x400	35
30F - 38F	900x400	1000x400	900x400	900x400	900x400	1000x400	900x400	900x400	35

Floor	TYPE SHEARWALL (mm)				F'C (Mpa)
	SW1	SW2	SW3	SW4	
	P= 7500	P= 1600	P= 6400	P= 4250	
-1F - 11F	550	550	500	400	50
13F - 23F	450	450			45
24F - ROOF	350	350			40

Table 2. Beam

Lantai	Tipe Balok		Properti	F'C (Mpa)
Balok Lt. 1	B412	Beton	400 x 1200	40
Balok Lt. 1	B412A-2	Beton	400 x 1130	40
Balok Lt. 1	B311A	Beton	300 x 780	40
Balok Lt. 1	B73A	Beton	700 x 350	40
Balok Lt. 1	B66	Beton	600 x 600	40
Balok Lt. 1	B66A	Beton	600 x 650	40
Balok Lt. 1 - 4	B2A4	Beton	250 x 400	40
Balok Lt. 1 - 4	B2A5	Beton	250 x 500	40
Balok Lt. 1 - 4	B4A7A	Beton	450 x 750	40
Balok Lt. 1 - 4	B76A	Beton	700 x 650	40
Balok Lt. 1 - 4	B45	Beton	400 x 500	40
Balok Lt. 1 - 4	B47	Beton	400 x 700	40
Balok Lt. 1 - 4	B4A10	Beton	450 x 1000	40
Balok Lt. 5 - 24	B2A5A	Beton	250 x 550	35
Balok Lt. 5 - 24	B2A6A	Beton	250 x 650	35
Balok Lt. 5 - 24	B3A5A	Beton	350 x 550	35
Balok Lt. 5 - 24	B3A5A1	Beton	350 x 560	35
Balok Lt. 5 - 24	B2A7A3	Beton	250 x 780	35
Balok Lt. 5 - 24	B37A3	Beton	300 x 780	35
Balok Lt. 5 - 24	B57	Beton	500 x 700	35
Balok Lt. 5 - 24	B59	Beton	500 x 900	35
Balok Lt. 5 - 24	B410A3	Beton	400 x 1080	35
Balok Lt. 5 - 24	B612	Beton	600 x 1200	35
Balok Lt. 5 - 24	B69	Beton	600 x 900	35
Balok Lt. 5 - 24	B46	Beton	400 x 600	35
Balok Lt. 5 - 24	B103A	Beton	1000 x 350	35
Balok Lt. 5 - 24	B93A	Beton	900 x 350	35
Balok Lt. 25 - 38	B59	Beton	500 x 900	35
Balok Lt. 25 - 38	B46A	Beton	300 x 500	35
Balok Lt. 25 - 38	B55A	Beton	300 x 500	35
Balok Lt. 25 - 38	B56A	Beton	300 x 500	35
Balok Lt. 25 - 38	B47A	Beton	300 x 500	35
Balok Lt. 25 - 38	B45A	Beton	300 x 500	35
Balok Lt. 25 - 38	B35A	Beton	300 x 500	35
Balok Lt. 25 - 38	B83A	Beton	800 x 350	35
Balok Lt. 25 - 38	B45A	Beton	300 x 500	35
Balok Lt. 25 - 38	B35A	Beton	300 x 500	35
Balok Lt. 25 - 38	B2A6A	Beton	300 x 500	35
Balok Lt. 25 - 38	B34A1	Beton	300 x 500	35
Balok Lt. 5 - 38	B2A4	Beton	300 x 500	35
Balok Lt. 5 - 38	B23	Beton	300 x 500	35
Balok Lt. 5 - 38	B24	Beton	300 x 500	35
Balok Lt. 5 - 38	B24"	Beton	300 x 500	35
Balok Lt. 5 - 38	B25	Beton	300 x 500	35
Balok Lt. 5 - 38	B2A3A	Beton	300 x 500	35
Balok Lt. 5 - 38	B4A6	Beton	300 x 500	35

Table 3. Thickness of Concrete Slab

floor	Tebal (mm)
Graund flor	concrete 150
Floor 1	concrete 150
Floor 2	concrete 130
Floor 3-4	concrete 120
Floor 5-38	concrete 120
Ro of top	concrete 150

Table 4. Quality Material

Structure element	Cobcrete grade	Component character
Raft foundation	FC35	35
Coloumn and shearwall	FC /3540/45/50	35/40/45/50
Girder / beam	FC 35	35
slab	FC 35	35

Table 5. Structure element

Structure element	Cobcrete grade	Component character
Raft foundation	FC35	35
Coloumn and shearwall	FC /3540/45/50	35/40/45/50
Girder / beam	FC 35	35
slab	FC 35	35

3.2. Loading

1. Static Load

Static analysis in principle is to replace earthquake loads with seismic forces static equivalent which aims to simplify and simplify calculations. This method is also called the Equivalent Lateral Force Method, which assumes the magnitude of the earthquake force based on the product of a constant/mass of the element.

Table 6. Dead Load of Construction Materials and Building Components

No	Material konstruksi	(Kg/m ³)
1	Steel	7850
2	Conciete	2200
3	Reinforced ConCrete	2500
4	Wood (Everage Value of different types of wood)	1000
5	Red Bricks	1700
6	Pair Of split stones, cobblestones, mountain stones	2200
7	Sand (air dry to moist)	1600-1700
8	Sand (saturated with water)	1800
9	Soll,logam and still (dry – wet)	1700-2000
10	split	1450

Table 7. Self Weight of Building Components

NO	Komponen gedung	Beban mati (kg/m ²)
1	Stir (per cm think)	
	-From cement	21
	- Of lime, red cement or tras	17
2	Ceiling (including ribs, whithout hangers)	
	-Asbestos cement /plasterboard (max 4mm thick)	11
	Glass (3-5 mm Thick)	10
3	Red mas onry wall	
	-one stone	450
	-half a stone	250
4	Brick ma sonry wall	
	-perforated (20 cm thick)	200
	-perforated (10 cm thick)	120
	-no holes (15 cm thick)	300
	no holes (10 cm thick)	200
5	Wave asbestos cement (5mm think)11	11
6	Simple wooden floor , no ceiling	40
7	Wooden ceiling hanger (max 5 m span)	7
8	Cemment/concrete floor coverings (per cm thick)	24

Table 8. Live Load On Structure

Live loads on Floors of large building	Burden
Floor 250 kg m ²	250kg/m ²
Stairs and beban 300kg/m ²	300kg/m ²
Roof plate 100kg/m ²	100kg/m ²
Floor tool and marchine room 400kg/m ²	400kg/m ²

2. Dynamic Load

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Table 9. Definition of Soil Type (SNI 1726-2002)

Type of soil	Average shear wave velocity (vs)(m/s)	The average standard penetration test result value (N)	Average shear strength u (kPa)
Hard soil	$V_s \geq 350$	$N \geq 50$	$su \geq 100$
Medium ground	$175 \leq v_s < 350$	$15 \leq N < 50$	$50 \leq su < 100$
Soft soil	$V_s < 175$	< 15	
Soft soil	$V_s < 175$	< 15	
Or < all types of soft clay with a total thickness of more than 3 meter with $PI > 20$, $w_n > 40\%$ and $u < 25 \text{ Kpa}$			
Special and	A special evaluation is required at each location		

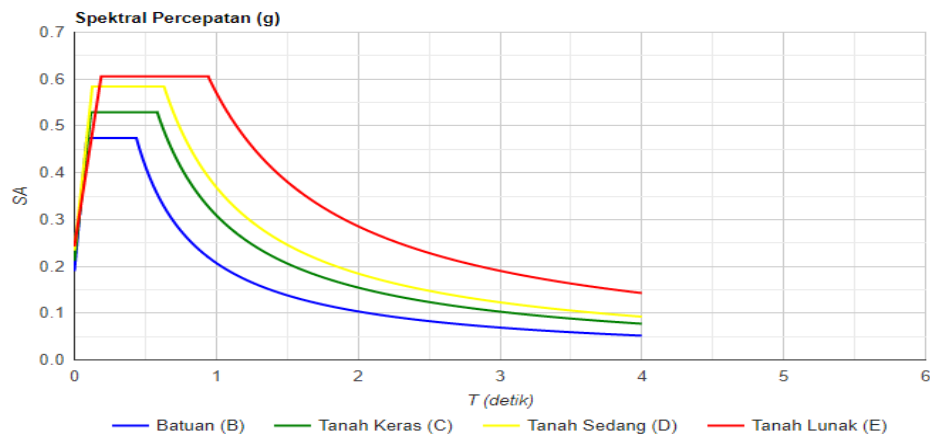


Figure 11 .Response Spectrum for the AlamSutera Areas

Table 10. Spectral Results Table for the AlamSutera Areas

Rock	Variable	Point	Hard	Variable	Point	Medium	Variable	Point	Soft	Variable	Point
	PGA (g)	0,373	Soil	PGA (g)	0,373	Ground	PGA (g)	0,373	Soil	PGA (g)	0,373
	S _S (g)	0,712		S _S (g)	0,712	/ Soil	S _S (g)	0,712		S _S (g)	0,712
	S ₁ (g)	0,311		S ₁ (g)	0,311		S ₁ (g)	0,311		S ₁ (g)	0,311
	C _{RS}	0,996		C _{RS}	0,996		C _{RS}	0,996		C _{RS}	0,996
	C _{R1}	0,936		C _{R1}	0,936		C _{R1}	0,936		C _{R1}	0,936
	F _{PGA}	1		F _{PGA}	1,027		F _{PGA}	1,127		F _{PGA}	0,98
	F _A	1		F _A	1,115		F _A	1,231		F _A	1,277
	F _V	1		F _V	1,489		F _V	1,778		F _V	2,756
	PSA (g)	0,373		PSA (g)	0,383		PSA (g)	0,421		PSA (g)	0,366
	S _{MS} (g)	0,712		S _{MS} (g)	0,794		S _{MS} (g)	0,876		S _{MS} (g)	0,909
	S _{M1} (g)	0,311		S _{M1} (g)	0,463		S _{M1} (g)	0,553		S _{M1} (g)	0,857
	S _{DS} (g)	0,474		S _{DS} (g)	0,529		S _{DS} (g)	0,584		S _{DS} (g)	0,606
	S _{D1} (g)	0,207		S _{D1} (g)	0,309		S _{D1} (g)	0,369		S _{D1} (g)	0,571
	T ₀ (detik)	0,087		T ₀ (detik)	0,117		T ₀ (detik)	0,126		T ₀ (detik)	0,189
	T _S (detik)	0,437		T _S (detik)	0,583		T _S (detik)	0,631		T _S (detik)	0,944

Table 11. Priority Factors For Various Categories Of Buildings

Building category	Priority favior		
	1	1	1
Public building such as for residential, commercial and office.	1	1,6	1,6
Monumentals and buildings monumentals	1,4	1	1,4
Important buildings after the earthquake such as hospitals, clean water installation, power plants ,emergency rescue centers, radio and television facility	1,6	1	1,6
Buildings for storing hazardous materials such as gas, petroleum product ,acids,toxic materials Chimney, tank on tower	1,4	1	1,5

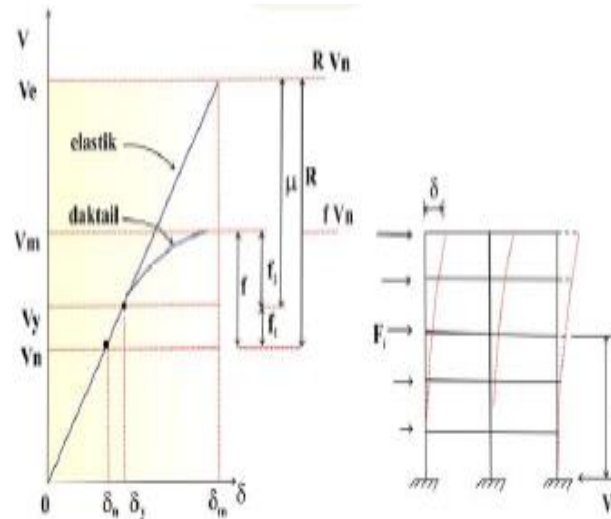


Figure 12. Load Diagram (V) - Deviation (δ) of the Building Structure

Table 12. Peak acceleration of bedrock and peak ground acceleration for each Indonesian Earthquake Region

earthquake region	Peak acceleration of bedrock ('g')	Peak acceleration of bedrock ('g')			
		Hard soil	Medium Ground	Soft soil	Special land
1	0,03	0,04	0,05	0,08	A special evaluation is required at each location
2	0,1	0,12	0,15	0,2	
3	0,15	0,18	0,23	0,3	
4	0,2	0,24	0,28	0,34	
5	0,25	0,28	0,32	0,36	
6	0,3	0,33	0,36	0,38	

Table 13. Coefficient of Vibration Time of Earthquake Area Structure

Earthquake region	Limiting coefficient ('g')
1	0,2
2	0,19
3	0,18
4	0,17
5	0,16
6	0,15

Table 14. Estimated Amount of Ksv Price for Several Types of Land

Type of soil	Range price ksw (kN/m3)
sand	
Loose sand	4500-15000
Medium sand	9000-75000
Dense sand	60000-120000
Clayey sand	30000-75000
Silty sand	22500-45000
Clay	
Qu<4kPa	11250-22500
4kPa<qu<8kPa	22500-45000
8kPa<qu	>45000

Table 15. Maximum Permit Deflection

Structural Component Type	Calculated Deflection	Limit Deflection
Flat roofs that do not support or are not attached to non-structural components that may be damaged by large deflections	Instantaneous deflection due to live load (LL)	$\frac{l^a}{180}$
Floors that do not support or are not attached to non-structural components that are likely to be damaged by large deflections	Instantaneous deflection due to live load (LL)	$\frac{l}{360}$
Roof or floor construction that supports or is attached to non-structural components that are likely to be damaged by large deflections	Part of the total deflection that occurs after the installation of non-structural components (sum of the long-term deflection, due to all fixed loads acting, and the instantaneous deflection, due to the addition of live loads)	$\frac{l^b}{480}$
Roof or floor construction that supports or is attached to non-structural components that are unlikely to be damaged by large deflections.		$\frac{l^d}{240}$
^a These limits are not intended to prevent possible waterlogging. The possibility of inundation should be checked by calculating the deflection, including the additional deflection due to the inundation, and taking into account the long-term effects of the always-acting load, deflection resistance, construction tolerances and the reliability of the drainage system.		
^b The deflection limit may be exceeded when steps have been taken to prevent damage to the supported or joined components.		
^c Long-term deflection shall be calculated according to the provisions of 11.5(2(5)) or 11.5(4(2)), but may be reduced by the value of the deflection occurring before the addition of non-structural components. The value of this deflection must be determined on the basis of acceptable technical data regarding the characteristics of the relationship between time and deflection of the structural member which is similar to that of the member under review.		
^d But it must not be greater than the tolerance provided for non-structural components. This limit may be exceeded if there is a counter deflection provided such that the total deflection minus the counter deflection does not exceed the existing deflection limit.		

3. Combination of Loading

the load combination becomes as described below:

- 1,4 DL
- 1,2 DL + 1,6 LL
- 1,2 DL + 1 LL $\pm 0,3 (\rho Q_e + 0,2 S DS DL) \pm 1 (\rho Q_e + 0,2 S DS DL)$
- 1,2 DL + 1 LL $\pm 1 (\rho Q_e + 0,2 S DS DL) \pm 0,3 (\rho Q_e + 0,2 S DS DL)$
- 0,9 DL $\pm 0,3 (\rho Q_e + 0,2 S DS DL) \pm 1 (\rho Q_e + 0,2 S DS DL)$
- 0,9 DL $\pm 1 (\rho Q_e + 0,2 S DS DL) \pm 0,3 (\rho Q_e + 0,2 S DS DL)$

For redundancy equal to 1.3 ($\rho = 1,3$) and $S DS = 0.457$, the translation results are as in Table 4.6.3.1 below

:

Table 16. Combination table based on results of SAP2000 v21

Combo Name	Combo Type	Case Name	Scale Factor				
1.4SDL + 1.4 DL	Linear Add	DEAD	1.4	1.34SDL+1.34DL+0.5L L+0.3EQX-1EQY		DX	0.3
1.4SDL + 1.4 DL		SUPERDEAD	1.4	1.34SDL+1.34DL+0.5L L+0.3EQX-1EQY		DY	-1.
1.34 SDL + 1.34 DL + 1.6 LL	Linear Add	DEAD	1.34	1.34SDL+1.34DL+0.5L L+1.0EQX+0.3EQY	Linear Add	DEAD	1.34
1.34 SDL + 1.34 DL + 1.6 LL		SUPERDEAD	1.34	1.34SDL+1.34DL+0.5L L+1.0EQX+0.3EQY		SUPERDEAD	1.34
1.34 SDL + 1.34 DL + 1.6 LL		Live	1.6	1.34SDL+1.34DL+0.5L L+1.0EQX+0.3EQY		Live	0.5
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY	Linear Add	DEAD	1.34	1.34SDL+1.34DL+0.5L L+1.0EQX+0.3EQY		DX	1.
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY		SUPERDEAD	1.34	1.34SDL+1.34DL+0.5L L+1.0EQX+0.3EQY		DY	0.3
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY		Live	0.5	1.34SDL+1.34DL+0.5L L-1.0EQX-0.3EQY	Linear Add	DEAD	1.34
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY		DX	0.3	1.34SDL+1.34DL+0.5L L-1.0EQX-0.3EQY		SUPERDEAD	1.34
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY		DY	1.	1.34SDL+1.34DL+0.5L L-1.0EQX-0.3EQY		Live	0.5
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY	Linear Add	DEAD	1.34	1.34SDL+1.34DL+0.5L L-1.0EQX-0.3EQY		DX	-1.
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY		SUPERDEAD	1.34	1.34SDL+1.34DL+0.5L L-1.0EQX-0.3EQY		DY	-0.3
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY		Live	0.5	1.34SDL+1.34DL+0.5L L+1.0EQX-0.3EQY	Linear Add	DEAD	1.34
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY		DX	-0.3	1.34SDL+1.34DL+0.5L L+1.0EQX-0.3EQY		SUPERDEAD	1.34
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY		DY	-1.	1.34SDL+1.34DL+0.5L L+1.0EQX-0.3EQY		Live	0.5
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY	Linear Add	DEAD	1.34	1.34SDL+1.34DL+0.5L L+1.0EQX-0.3EQY		DX	1.
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY		SUPERDEAD	1.34	1.34SDL+1.34DL+0.5L L+1.0EQX-0.3EQY		DY	-0.3
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY		Live	0.5	1.34SDL+1.34DL+0.5L L+1.0EQX-0.3EQY	Linear Add	DEAD	1.34
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY		DX	-1.	1.34SDL+1.34DL+0.5L L+1.0EQX-0.3EQY		SUPERDEAD	1.34
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY		DY	0.3	1.34SDL+1.34DL+0.5L L+1.0EQX-0.3EQY		Live	0.5
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY		DX	-1.	1.34SDL+1.34DL+0.5L L+1.0EQX-0.3EQY		DX	-1.
1.34SDL+1.34DL+0.5L L+0.3EQX+1EQY		DY	0.3	1.34SDL+1.34DL+0.5L L+1.0EQX-0.3EQY		DY	0.3

0.76SDL+0.76DL+0.3EQX+1.0EQY	Linear Add	DEAD	0.76	0.76SDL+0.76DL+1.0EQX+0.3EQY		QUAKE X	1.
0.76SDL+0.76DL+0.3EQX+1.0EQY		SUPERDEAD	0.76	0.76SDL+0.76DL+1.0EQX+0.3EQY		DY	0.3
0.76SDL+0.76DL+0.3EQX+1.0EQY		DX	0.3	0.76SDL+0.76DL-1.0EQX-0.3EQY	Linear Add	DEAD	0.76
0.76SDL+0.76DL+0.3EQX+1.0EQY		DY	1.	0.76SDL+0.76DL-1.0EQX-0.3EQY		SUPERDEAD	0.76
0.76SDL+0.76DL-0.3EQX-1.0EQY	Linear Add	DEAD	0.76	0.76SDL+0.76DL-1.0EQX-0.3EQY		DX	-1.
0.76SDL+0.76DL-0.3EQX-1.0EQY		SUPERDEAD	0.76	0.76SDL+0.76DL-1.0EQX-0.3EQY		DY	-0.3
0.76SDL+0.76DL-0.3EQX-1.0EQY		DX	-0.3	0.76SDL+0.76DL+1.0EQX-0.3EQY	Linear Add	DEAD	0.76
0.76SDL+0.76DL-0.3EQX-1.0EQY		DY	-0.3	0.76SDL+0.76DL+1.0EQX-0.3EQY		SUPERDEAD	0.76
0.76SDL+0.76DL+0.3EQX-1.0EQY	Linear Add	DEAD	0.76	0.76SDL+0.76DL+1.0EQX-0.3EQY		DX	1.
0.76SDL+0.76DL+0.3EQX-1.0EQY		SUPERDEAD	0.76	0.76SDL+0.76DL+1.0EQX-0.3EQY		DY	-0.3
0.76SDL+0.76DL+0.3EQX-1.0EQY		DX	0.3	0.76SDL+0.76DL-1.0EQX+0.3EQY	Linear Add	DEAD	0.76
0.76SDL+0.76DL+0.3EQX-1.0EQY		DY	-1.	0.76SDL+0.76DL-1.0EQX+0.3EQY		SUPERDEAD	0.76
0.76SDL+0.76DL-0.3EQX+1.0EQY	Linear Add	DEAD	0.76	0.76SDL+0.76DL-1.0EQX+0.3EQY		DX	-1.
0.76SDL+0.76DL-0.3EQX+1.0EQY		SUPERDEAD	0.76	0.76SDL+0.76DL-1.0EQX+0.3EQY		DY	0.3
0.76SDL+0.76DL-0.3EQX+1.0EQY		DX	-0.3	1.34SDL+1.34DL+0.5L-0.3EQX+1EQY	Linear Add	DEAD	1.34
0.76SDL+0.76DL-0.3EQX+1.0EQY		DY	-1.	1.34SDL+1.34DL+0.5L-0.3EQX+1EQY		SUPERDEAD	1.34
0.76SDL+0.76DL+1.0EQX+0.3EQY	Linear Add	DEAD	0.76	1.34SDL+1.34DL+0.5L-0.3EQX+1EQY		Live	0.5
0.76SDL+0.76DL+1.0EQX+0.3EQY		SUPERDEAD	0.76	1.34SDL+1.34DL+0.5L-0.3EQX+1EQY		DX	-0.3
				1.34SDL+1.34DL+0.5L-0.3EQX+1EQY		DY	1.

3.3. Results of Analysis Static

The results from the SAP2000 v21Avizan & Koespiadi, (2020) program, the floor shear force due to dynamic earthquake loads is generated by inputting the seismic response spectrum used based on the earthquake zone used. The following is a graph of the SAP2000 v21 input spectrum response.

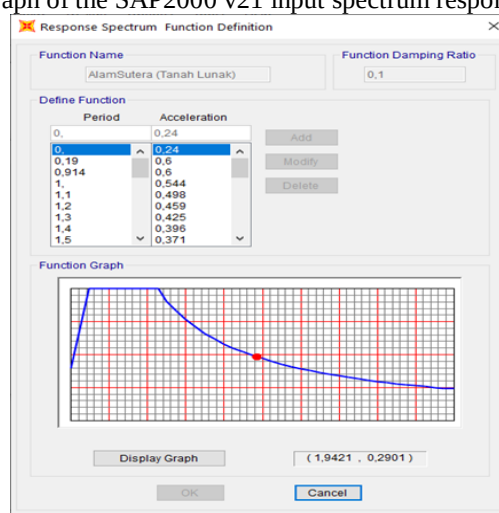


Figure 13. Density Change of Concrete Samples (kg/m³)

Table 17. Response Spectrum SkyHouse Alam Sutera

case	Load type	Load name	Coord sys	funtion	Angle degrees	Tran AccSF mm/sec2
DX	Acceleration	U1	GLOBAL	Alam Sutera	0.	1226.25
DY	Acceleration	U2	GLOBAL	Alam Sutera	0.	1226.3
QUAKE X	Acceleration	U1	GLOBAL	Alam Sutera	0.	1226.25
QUAKE Y	Acceleration	U2	GLOBAL	Alam Sutera	0.	1226.3

Table 18.. Dynamic Earthquake Response Based on SAP2000 V21 . Results

OutputCase	StepType	GlobalFX	GlobalFY	GlobalFZ	GlobalMX	GlobalMY	GlobalMZ
Text	Text	KN	KN	KN	KN-m	KN-m	KN-m
MODAL	Mode	0,04	-0,04	0,00	1,30	-4,77	-1,06
MODAL	Mode	-0,02	-0,04	0,00	6,11	2,18	-1,06
MODAL	Mode	0,00	0,08	0,00	-2,95	-0,40	-0,57
MODAL	Mode	0,00	0,00	-0,01	-0,11	0,30	0,20
MODAL	Mode	0,19	-0,06	-0,01	-1,21	-4,70	-4,50
MODAL	Mode	0,00	0,00	-0,02	-0,33	0,01	-0,03
MODAL	Mode	-0,06	-0,21	0,02	1,15	0,52	-5,32
MODAL	Mode	-0,01	0,00	0,02	0,38	-0,05	0,13
MODAL	Mode	-0,01	0,01	-0,05	-0,98	1,86	0,43
MODAL	Mode	0,00	-0,01	-0,02	-0,07	0,82	-0,36
MODAL	Mode	0,03	-0,39	0,02	6,65	0,54	3,33
MODAL	Mode	0,00	-0,01	0,03	0,51	-0,01	-0,06
SUPERDEAD		9618,34	-153662,91	3850049,57	72629247,20	-101615971,00	-2566202,52
DX	Max	9207,20	6323,26	248,40	297282,26	888095,30	206368,46
DY	Max	3175,18	8380,25	451,65	831265,92	332334,09	201556,47
QUAKE X	Max	9206,82	6323,00	248,39	297270,14	888059,09	206360,05
QUAKE Y	Max	3175,18	8380,25	451,65	831265,92	332334,09	201556,47

Table 19. Earthquake Period Based on SAP2000 V21 Results

Output Case	Step Type	Step Num	Period	Frequency	CircFreq	Eigenvalue
Text	Text	Unitless	Sec	Cyc/sec	rad/sec	rad2/sec2
MODAL	Mode	1	19,49909	0,051284	0,32223	0,10383199
MODAL	Mode	2	16,87373	0,059264	0,372365	0,13865567
MODAL	Mode	3	13,41779	0,074528	0,468273	0,21927939
MODAL	Mode	4	6,943229	0,144025	0,904937	0,81891103
MODAL	Mode	5	5,919126	0,168944	1,061506	1,12679422
MODAL	Mode	6	4,939493	0,20245	1,272031	1,61806163
MODAL	Mode	7	4,858961	0,205805	1,293113	1,67214096
MODAL	Mode	8	4,416993	0,226398	1,422503	2,02351411
MODAL	Mode	9	4,200074	0,238091	1,49597	2,23792645
MODAL	Mode	10	3,97254	0,251728	1,581654	2,50163061
MODAL	Mode	11	3,578329	0,27946	1,755899	3,08318161
MODAL	Mode	12	3,418921	0,29249	1,837769	3,37739306
Modus Min :			19,49909	0,29249	1,837769	3,37739306
Modus Max :			3,418921	0,051284	0,32223	0,10383199

Table 20. Modal Participation Factors

OutputCase	StepType	StepNum	Period	UX	UY	UZ	SumUX	SumUY	SumUZ	RX	RY	RZ	SumRX	SumRY	SumRZ
Text	Text	Unitless	Sec	Unitless	Unitless	Unitless	Unitless	Unitless	Unitless	Unitless	Unitless	Unitless	Unitless	Unitless	Unitless
MODAL	Mode	1	19,499087	0,59446	0,06909	0,00001845	0,59446	0,06909	0,00001845	0,03465	0,29144	0,00317	0,03465	0,29144	0,00317
MODAL	Mode	2	16,873728	0,06741	0,5613	0,00005235	0,66187	0,63039	0,00007079	0,26316	0,03449	0,07326	0,29781	0,32592	0,07643
MODAL	Mode	3	13,417789	0,00089	0,05051	0,00003582	0,66276	0,68089	0,00011	0,05028	0,00033	0,58756	0,34809	0,32625	0,66399
MODAL	Mode	4	6,943229	5,274E-11	4,673E-07	0,00018	0,66276	0,6809	0,00028	7,746E-07	0,00001928	7,375E-08	0,3481	0,32627	0,66399
MODAL	Mode	5	5,919126	0,14896	0,00614	0,00008868	0,81173	0,68704	0,00037	0,02116	0,18873	0,00131	0,36926	0,515	0,6653
MODAL	Mode	6	4,939493	7,295E-09	6,105E-08	0,00022	0,81173	0,68704	0,0006	0,000001082	0,00011	5,784E-08	0,36926	0,51511	0,6653
MODAL	Mode	7	4,858961	0,01079	0,10876	0,00029	0,82252	0,7958	0,00089	0,24769	0,01888	0,00776	0,61695	0,53399	0,67306
MODAL	Mode	8	4,416993	6,238E-08	0,000001161	0,00016	0,82252	0,7958	0,00105	0,00001169	0,00007062	5,177E-08	0,61696	0,53406	0,67306
MODAL	Mode	9	4,200074	1,908E-08	3,781E-08	0,00083	0,82252	0,7958	0,00187	0,00002259	0,00012	5,184E-09	0,61699	0,53418	0,67306
MODAL	Mode	10	3,97254	1,147E-07	6,959E-07	0,00013	0,82252	0,7958	0,002	0,00003362	0,00002323	0,00000137	0,61702	0,5342	0,67306
MODAL	Mode	11	3,578329	0,00039	0,01444	0,00011	0,82291	0,81024	0,00212	0,00872	0,00198	0,14158	0,62573	0,53619	0,81464
MODAL	Mode	12	3,418921	4,811E-08	5,469E-07	0,00019	0,82291	0,81024	0,00231	0,000001773	0,0001	0,0000107	0,62574	0,53629	0,81465
Modus Min :			19,499087	0,59446	0,5613	0,00083	0,82291	0,81024	0,00231	0,26316	0,29144	0,58756	0,62574	0,53629	0,81465
Modus Max :			3,418921	5,274E-11	3,781E-08	0,00001845	0,59446	0,06909	0,00001845	7,746E-07	0,00001928	5,184E-09	0,03465	0,29144	0,00317

4. Conclusion

After analyzing using the response spectrum method, the authors can draw the following conclusions based on the results of the SAP2000 v21 program.

1. comparison of the upper structure between planning data and modification data (For Construction) The results of the maximum displacement in the X direction are 0.02373 m and the Y direction is 0.181128 m so that it still meets the maximum limit $[(0.015hsx)/\rho] = 1.662$ m
2. Because the displacement and base shear results in the equivalent lateral force analysis are greater than in the variance response spectrum analysis, the results of the equivalent lateral force analysis are safer if used for the application of earthquake force loading in structural calculations.
3. The result of the comparison between the calculation of the nominal static shear force and the nominal dynamic shear analysis is greater.

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Biography

Agus Fernando

I am Agus Fernando, born in Jakarta, August 10, 1992. I started studying at Mercubuana University in 2016/2017 Now I work at the North Jakarta Administration of Water Resources Sub-dept. as PPJU. My work experience was mostly in engineering before I worked at the Water Resources Sub-Department, I worked as an Engineer for several projects including Structural Engineering at PT. Hyundai Aluminum Internasional, Head Engineer at PT. AluMakro Korea, Structural Draftsman at PT. Wijaya Karya and many more of my work experiences.

Syafwandi

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He was born in Jakarta, October 13, 1956. As Professor at UMB, Bachelors Degree at University Indonesia (1984), Masters degree at Institute Teknologi Bandung and University college London, 1988 and finish S3 as doctor at University Satyagama (2005).

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Comparative Analysis of Facade Work Using Kumkang Precast, Concrete Precast, and Curtain Wall Methods in terms of Cost and Time

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Abstract

The development of the construction world in terms of innovation has become one of the methods of supporting success to gain advantages in terms of cost and time, one of which is the outer wall which can generally categorize into cast-in-situ and precast methods. (1) Comparison of the cost of implementing precast kumkang materials, precast concrete facades, and curtain wall facades. The precast kumkang method is 24% cheaper than the precast concrete method, the precast kumkang method is 87% cheaper than the curtain wall method, and the precast concrete method is 52% cheaper than the curtain wall method. Sorted from the cheapest to the most expensive are precast kumkang facades, precast concrete facades, and curtain wall facades. (2) Comparison of the working time of precast kumkang materials, precast concrete facades, and curtain wall facades with the results, namely curtain wall facades for 31 weeks, kumkang material precast facades for 53 weeks, and precast concrete facades for 55 weeks. Sorted from the fastest to longest, namely curtain wall facades, precast kumkang material facades, and then precast concrete facades.

Keywords:

Construction Cost Analysis, Construction Time Analysis, Curtain Wall Facade Work, Kumkang Material Precast Facade Work, Precast Concrete Facade Work.

1. Introduction

1.1. Background

In construction work, the material was select by considering several aspects such as the required cost aspect, the processing time aspect, and the material management aspect to maximize a job Hidayat & Irvan, (2018). The building facade is the main face or front view of a building exterior that can see from the road or other public areas Soenarto et al., (2017). The big difference between the facade with the kumkang precast method, precast concrete, and curtain wall was using the formwork materials.

Aluminum panels are pre-design according to architectural plans to appear from the finished building with concrete. Forms into a single unit of columns, beams, stairs, shutters, facades, arched sections, and other intricate decorative features AYOMA Apartment, (2018). While the reference for object research for the precast concrete and curtain wall base on the Indonesian regulatory standards PermenPUPR and SNI. The precast concrete facade used standard formwork made of phenol film with casting carried out at the precast concrete factory. And for the curtain wall facade does not use formwork but melting glass raw materials into becoming glass tempered as a building wall covering panel.

1.2. Problem Identification

Based on the background, the researcher identified the existing problem as follows:

1. There is no comparison of facades between; the precast method of kumkang material to standard method concrete, or glass in terms of cost and time.
2. The development of the construction world today is required to pay attention to the aesthetics of the outside appearance.

1.3. Problem Formulation

Based on the background and problem identification, the researcher formulated the problem as follows:

1. What is the ratio of the costs required for the facade work on the kumkang material precast method, precast concrete, and curtain wall?
2. What is the ratio of the time required for facade work on the kumkang material precast method, precast concrete, and curtain wall?

2. Methods

2.1. Research Concept

This research is a study to determine the requirements of each facade work between the precast method of kumkang, concrete, and curtain wall materials in terms of cost and construction time.

Figure 1. Kumkang Material Precast Facade

Figure 1 shows that most of the stages of the precast kumkang material are different from the others.

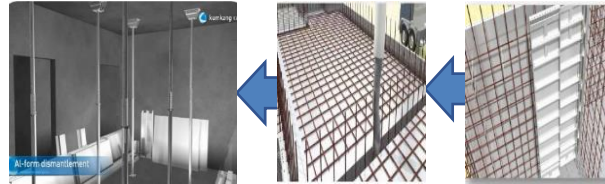


Figure 2. Precast Concrete Facade

Figure 2 shows most of the precast concrete facade stages.



Figure 3. Curtain Wall Facade

Figure 3 shows most of the different stages of the curtain wall facade from the others.



2.2. Research Methods

The research method in this study is comparative research with data in the form of numbers. The data obtained from the Mahata Margonda Apartment Project are BoQ, S curve, construction drawings, supporting data, AHSP PermenPUPR and SNI, and others. (1) The cost data is analyzed in AHSP format with RAB results for each method. (2) Time data is analyzed in terms of requirements per job with bar chart results from each method.

3. Result and Discussion

3.1. Result

(1) The cost analysis uses a two-part calculation. The first one is Unit Price Analysis/AHSP, which is the multiplication of material, labor, and equipment needs with unit prices according to each work according to the project area to complete the work unit. The second calculation is the volume of work needs, the multiplication of the two parts is explained in the Budget Plan/RAB, as shown in the table below:

Table 1. RAB Comparison

Ref	Description	Unit	Quantity	Rate (IDR)	Amount (IDR)
	(a) Kumkang Material Precast Facade				
	(b) Precast Concrete Facade				
	(c) Curtain Wall Facade				
	INDIRECT COST				(a) 20.387.897.432 (b) 21.902.374.861 (c) 31.809.817.250
	DIRECT COST				
	<u>STRUCTURE</u>				
A	Kumkang Formwork Delivery	Kg	(a) 3.758	(a) 135.000	(a) 507.297.466
B	Shipping of Curtain Wall Panels	Ton	(c) 7.400	(c) 195.497	(c) 1.446.680.813
C	Reinforcement Diameter 6	Kg	(b) 355	(b) 14.893	(b) 5.286.190
D	Reinforcement Diameter 8	Kg	(a) 1.023	(a) 14.799	(a) 15.142.573
E	Reinforcement Diameter 10	Kg	(a) 19.719 (b) 15.856	(a) 14.799 (b) 14.893	(a) 291.829.705 (b) 236.154.729
F	Reinforcement Diameter 12	Kg	(b) 2.562	(b) 14.893	(b) 38.149.863
G	Reinforcement Diameter 13	Kg	(a) 2.123	(a) 14.799	(a) 31.413.918
H	High Tensile Steel Mesh M6	Kg	(a) 7.128 (b) 9.123	(a) 13.145 (b) 13.108	(a) 93.694.873 (b) 119.584.928
I	Mullion Vertical Aluminum Frame	M'	(c) 4.552	(c) 283.602	(c) 1.290.891.663
J	Horizontal Transom Aluminum Frame	M'	(c) 1.534	(c) 196.214	(c) 301.084.740
K	Glass Stopsol Curtain Wall	M2	(c) 9.708	(c) 742.130	(c) 7.204.478.812
L	Formwork	M2	(a) 14.779 (b) 19.187	(a) 44.505 (b) 42.427	(a) 657.739.583 (b) 814.031.902
M	Reinforced Concrete Grade Fc' 30 Mpa	M3	(a) 591 (b) 767	(a) 343.565 (b) 729.073	(a) 203.103.130 (b) 559.535.487
N	Precast Concrete Facade Panels Delivery	Ton	(b) 1.842	(b) 57.181	(b) 105.322.252
O	Precast Shunt Work	Unit	(b) 603	(b) 61.194	(b) 36.900.142
P	Facade Panel Erection	Unit	(b) 603 (c) 28.360	(b) 62.352 (c) 35.595	(b) 37.598.128 (c) 1.009.467.821
Q	Install Precast Facade	M2	(b) 9.593 (c) 9.708	(b) 397.769 (c) 36.756	(b) 3.815.908.445 (c) 356.826.168
R	Grouting Facade Work	M2	(b) 1.919	(b) 6.890	(b) 13.219.056
	<u>ARCHITECTURE</u>				
A	Exposed Skim Coat Concrete Wall	M2	(a) 14.779 (b) 19.187	(a) 14.163 (b) 13.383	(a) 209.322.515 (b) 256.768.720
B	External Wall Painting	M2	(a) 7.390 (b) 9.593	(a) 18.758 (b) 17.445	(a) 138.613.644 (b) 167.352.745
C	Door and Windows	Unit	(a) 535 (b) 535 (c) 535	(a) 2.782.386 (b) 2.782.386 (c) 2.782.386	(a) 1.488.576.702 (b) 1.488.576.702 (c) 1.488.576.702

Table 1 shows indirect costs derived from staff costs and preparation costs by adjusting each method of facade work. As for the direct costs, which are divided into two categories of structural and architectural work, derived from all stages of the process to work on each facade method, the researcher calculates from unfinished materials to finished installing at the project site.

(2) The time analysis used worker productivity time in the AHSP coefficient to obtain the total time for each job and described in a bar chart. A bar chart is a set of activities place in a vertical column, while time is placed in a horizontal row. The start and end times of each activity and their duration are indicated by placing a horizontal block on the right side of each activity (Manto, 2016), as shown in the table below:

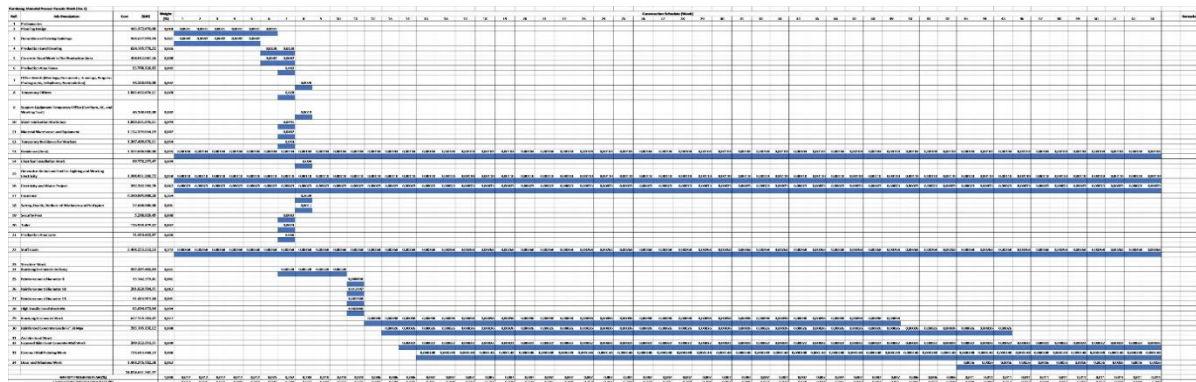


Figure 4. Bar Chart Facade Kumkang Material Precast
 Figure 4 is a reduced kumkang precast facade bar chart, containing the entire work time.

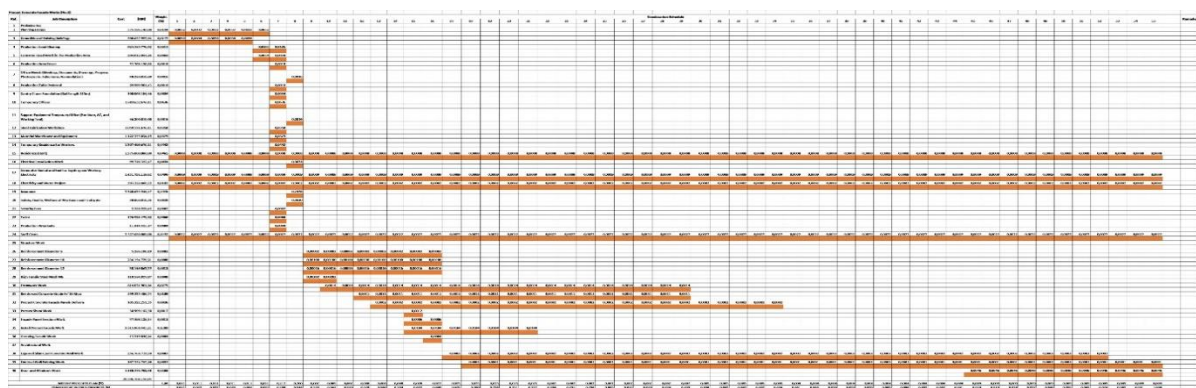


Figure 5. Bar Chart Facade Precast Concrete
 Figure 5 is a reduced precast concrete facade bar chart, containing the overall working time



Figure 6. Curtain Wall Facade Bar Chart
 Figure 6 is a reduced curtain wall facade bar chart, containing the overall work time.

Bar charts can use for making project scheduling. Figures 4, 5, and 6 describe the total scheduling it's explained assumption the researcher does overlapping work. The preliminaries work is carried by building temporary buildings at the project site simultaneously. Structural and architectural work does with the assuming of researchers that every structural work per floor is finish after the architectural will immediately follow, and so on until all work is complete.

Table 2. Facade Comparission

Ref	Description	Kumkang Material Precast Facade (IDR)	Precast Concrete Facade (IDR)	Curtain Wall Facade (IDR)
EXTERIOR WORK				
I	Indirect Cost	20.387.897.432	21.902.374.861	31.809.817.250
II	Structure Works			
A	Kumkang Formwork Delivery	507.297.466		
B	Shipping of Curtain Wall Panels			1.446.680.813
C	Reinforcement Diameter 6 Work		5.286.190	
D	Reinforcement Diameter 8 Work	15.142.573		
E	Reinforcement Diameter 10 Work	291.829.705	236.154.729	
F	Reinforcement Diameter 12 Work		38.149.863	
G	Reinforcement Diameter 13 Work	31.413.918		
H	High Tensile Steel Mesh M6 Work	93.694.873	119.584.928	
I	Mullion Vertical Aluminum Frame Work			1.290.891.663
J	Horizontal Transom Aluminum Frame Work			301.084.740
K	Glass Stopsol Curtain Wall Work			7.204.478.812
L	Formwork Work	657.739.583	814.031.902	
M	Reinforced Concrete Grade Fc' 30 Mpa (thick 8mm)	203.103.130	559.535.487	
N	Precast Concrete Facade Panels Delivery		105.322.252	
O	Precast Shunt Work		36.900.142	
P	Facade Panel Erection		37.598.128	1.009.467.821
Q	Install Precast Facade		3.815.908.445	356.826.168
R	Grouting Facade Work		13.219.056	
III	Architectural Works			
A	Exposed Skim Coat Concrete Wall Work	209.322.515	256.768.720	
B	External Wall Painting Work	138.613.644	167.352.745	
C	Door and Windows Work	1.488.576.702	1.488.576.702	1.488.576.702
Additional Explanation :				
1	Amount Per Square Meter			
a	Structure	551.014	1.384.887	1.489.794
b	Architectural	2.815.308	2.813.214	2.782.386
2	Working Time (Architecture overlap of finished structure)	Total 53 Weeks	Total 55 Weeks	Total 31 Weeks
a	Structure	39 Weeks	26 Weeks	23 Weeks
b	Architectural	40 Weeks	39 Weeks	11 Weeks
3	Number of Labor (Structure + Architecture) Per Square Meter	23 Labor	36 Labor	26 Labor
4	Specification	- Brand (Kumkang Kind) - Cast-in-situ concrete - Concrete Fc' 30 (t = 80 mm)	- Brand (BEP) - Precast Concrete (Factory) - Concrete Fc' 30 (t = 80 mm)	- Brand (Asahimass) - Special Attention to The Connection - Glass Stopsol Dark Blue (t = 80 mm)
5	Advantages and Disadvantages			

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Ref	Description	Kumkang Material Precast Facade (IDR)	Precast Concrete Facade (IDR)	Curtain Wall Facade (IDR)
a	Advantages	- Fast & safe assembly and disassembly - Smooth results without additional plastering - All in one system - Mobility without a tower crane - Design freedom due to modular - Durability used for 250 times repetition	- Fast, economical & simple - Optimum material & good quality - Planning in the factory with meticulous results - Easy finishing - Variation of models, elements, labor as needed	- Appearance as desired, clean & luxurious - Save time & installation budget - Interior with wide & spacious view - Can carry their burden
b	Disadvantages	- Pre-planning must be ripe - Not flexible in future design changes - The initial cost is relatively huge - Facade platform holes for formwork installation	- Different types make it more expensive - Size must match the lifting equipment and other equipment - Special attention to the connection	- The installation location must be clean so that there is no leak - High precision in mounting the stand - Requires Spiderman (Rope + Harnes) for workers
		  The Ayoma Apartemen	  The Elements Apartemen	  The Windsor Apartemen

3.2. Discussion

(1) In the RAB calculation, the indirect cost of the kumkang precast facade comes from staff costs for a total of 53 weeks of work, a total of 17% of the indirect costs of 3.4 billion, the rest is used for preparation costs, while the cost of the structure comes from the delivery of aluminum formwork from South Korea. Cast structure work on-site and architectural work carried out at the project site.

For indirect costs of precast concrete facades, the staff is calculated for a total working time of 55 weeks by 16% or 3.5 billion with the remaining preparation costs. The structure costs come from the manufacture of precast concrete facade panels at the factory site to delivery to the project site and the architectural cost required to complete the work at the project site.

And for curtain wall facades, indirect costs come from staff costs for 31 weeks of 7% or 2.1 billion and preparation work costs, besides structure work costs starting from the manufacturing process at the factory to installing aluminum and glass frames to finishing at the project site.

(2) In calculating the work time, the researcher used the labor productivity time in the AHSP coefficient for the unit of work and determined it according to the total volume of work required. Design work takes six weeks for all facade methods, all preparation time tailored to each work method, precast concrete takes at most 67 weeks, curtain wall takes at least 43 weeks, and precast kumkang material is 65 weeks. The total time required to precast the kumkang material is 159 weeks, precast concrete takes 182 weeks, and curtain wall takes at least 57 weeks. The researcher assumes that were preliminaries, structural and architectural works finished parallel, with the method of finished work per floor, the same as preliminaries work items can be done simultaneously.

To answer the background of the research problem on external aesthetics, the researchers measured using the Birkhoff formula, namely Aesthetic Measure. The validation results for construction project experts and university lecturers were four people, more than two people stated that the kumkang material precast facade expresses a very in order structure with the least amount of detail or complexity, precast concrete facade expresses a fairly aesthetic building with an average level of attractiveness, and the curtain wall facade expresses a building with poor aesthetics and with a high level of attractiveness.

4. Conclusion

Based on the research conducted, the researchers can conclude the following results as follow:

- (1) The comparison cost of the facade work among the three methods are; kumkang material of precast is 24% cheaper than the facade of the precast concrete, then kumkang material of precast is 87% cheaper than the facade of the curtain wall method. And precast concrete facade is 52% cheaper than the facade of the curtain wall method.
- (2) The comparison work of the time of the facade work among three methods are; curtain wall method is 22 weeks faster than the kumkang material of precast facades. The curtain wall facade is 24 weeks faster than precast concrete facades, and the kumkang material of precast facades is two weeks earlier than the facade precast concrete method.

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Dear writer's family. To the writer's closest friend and fellow regular civil engineering student 2 Mercu Buana University. Mrs. Irriene Indah Susanti, S.T, M.T as the Advisor for the Final Project. And the Mahata Margonda Apartment Project team and all parties who cannot be mention one by one.

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Biography / Biographies

Iriene Indah Susanti S.T, M.T was born on January 15, 1983. She is active in construction management projects civil in Indonesia and also a lecturer in Construction Management at the Faculty of Civil Engineering, Mercu Buana University, Jakarta. Completed her Master's Degree in Civil Engineering with a concentration in Infrastructure Management from Bandung Institute Technology with the title of her thesis, "Application of Failure Mode and Impact Analysis (FMEA) on Airport Infrastructure.

Maria Siwi Tiarasari is a researcher for this subject, was graduated as a bachelor's degree student majoring in civil engineering at Mercu Buana University, Jakarta, Indonesia. Previously she was a diploma graduate majoring in civil engineering from the Jakarta State Polytechnic, Depok, Indonesia, with a final project topic was construction risk management. After graduating with a diploma in 3, she worked as an assistant quantity surveyor at PT Rider Levett Bucknall for approximately one year. Then she decided to stop and continue her studies as a student to get a bachelor's degree. While studying, she made a home renovation project with the output project is drawings, costs, and material needs. Where this project is a collaboration with her father as part of the construction drawings, and she is the one who calculates the costs like the previous work. Therefore, researchers are interested in understanding the cost of project construction more deeply and take this research for her final project as a requirement for undergraduate graduation.

Living Lab Concept for Sensor Based Energy Performance Assessment of Houses

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Abstract

All the social, economic and industrial development depends on the availability of energy. Since energy demand is increasing exponentially throughout the world, more and more CO₂ is being emitted out into the atmosphere, giving rise to global warming. Therefore, establishing a sustainable environment is becoming increasingly important. It has been found through research that domestic sector contributes a great deal to the rising energy consumption. Due to prevailing energy crisis, efforts are being made to reduce the increasing energy consumption and make efficient use of energy by making the buildings energy efficient. For this, realistic assessment of energy use patterns in existing houses and buildings is necessary to assure dataset accuracy. Living lab concept integrated with sensor technologies can be used for assessment of such patterns. This paper presents living lab concept for sensor-based energy performance assessment of Houses. First, detailed literature review to benchmark concepts of energy efficiency of buildings, living labs concept, sensor based assessment, energy audit, and application of living lab concept has been discussed. Thereafter, sensors based living lab assessment and living lab approach has been introduced as being utilized by the author in a research project for development of guidelines for energy efficient housing. The paper also highlights important parameters to be monitored that effect energy performance. The concept reflects usefulness of living lab concept for sensor-based energy performance assessment of houses that help in substantial reduction in the energy consumption. As such data can be utilized for both realistic energy simulations by improving level of development of models as well as better usage comparisons with modeled analysis, hence helping in identifying true and effective improvement measures

Keywords:

Energy Efficient, Energy Performance, Living Lab Concept, Sustainable Environment

1. Introduction

It has been discovered that around 40% of the global energy use is ascribed to the buildings, be it commercial, residential and office Friedman et al. (2014). Especially residential buildings are the significant consumers of energy in many countries. Pakistan has one of the highest domestic energy consumption rates in the world and is facing the severe energy crisis for decades. Therefore, it is extremely important to create an environment that is sustainable. In order to do so, reducing the energy consumption is one of the most important strategies. This is achieved through efficient use of energy by making the buildings energy efficient. An energy-efficient building is a high performing building with the least possible amount of energy consumption by maximizing the efficient use of resources. Alike constructing a new energy efficient building, retrofitting of existing buildings and houses also result in real-time cost-effective outcomes. For this, energy performance assessment of the existing houses is carried out through simulation software. In order to make such assessment realistic, users (habitants) of the houses are required to be involved through their use patterns. This involvement will result in realistic energy consumption patterns, increased level of development of simulation models, and hence accurate energy performance assessment. Living lab concept is a solution. Living lab concept is one of the emerging concepts that provides the opportunity to gather the real-time data using Information and Communication Technology (ICT) and Internet of Things (IoT). Using living labs base assessment, users can shape innovation in their daily real-life environments for better quality of life. Living lab is typically referred as a facility that operates in a real-life context with an experimental, user-centric approach having user involvement, collaborating and co-producing knowledge. Living lab seeks to support prototyping, validating and refining the guidelines made to improve and make the facility energy efficient. This paper provides details on concepts of energy efficiency in residential buildings and houses, concepts of living lab and sensors assisted energy performance assessments through comprehensive literature review. Thereafter, it presents a Living Lab Concept

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for Sensor Based Energy Performance Assessment of Houses. This is being utilized by the principal author for research project for development of guidelines for energy efficient housing. The idea of paper is to provide analytical review of sensor assisted living lab concept and introduce a concept in practice.

2. Literature Review

2.1. Energy Efficient Buildings

Energy efficient buildings are defined as the buildings that are designed or upgraded to require less energy for space and cooling regardless of the source of energy or equipment Isover and Gobain (2020). These buildings have relatively reduced energy demand, hence, more energy efficiency. Construction of energy efficient buildings and retrofitting of existing buildings for better energy performance, aids in the reduction of increasing energy consumption. There are two significant strategies adopted for making existing buildings energy efficient. These are active and passive strategies. Active strategies usually include altering parameters like; cooling and heating systems, while building orientation, insulation, windows and daylighting, air sealing and natural ventilation opportunities are included in passive design measures.

2.2. Energy Assessment of Buildings

Energy assessment of buildings helps in identifying how and where the most of energy is being consumed. This gives owners ideas to make buildings energy efficient.

There are important factors in order to determine building energy performance, which include: energy systems, climate, building envelop, building services, building operation and maintenance, indoor environmental quality, occupants' activities and behavior Wang et al.(2012). There are three methods for the quantification of energy consumption:

1. Calculation based method: It involves the simulation based energy assessment of building using simulation engines like Autodesk Revit, Green building studio etc.
2. Measurement based method: It involves measurement of the energy consumption by using different methods such as using energy bills or meters.
3. Hybrid method: This method is a combination of both calculations based and measurement-based methods.

The hybrid method is the one, whose needs and methods are in alignment with the use of IoT (sensor technology) and living lab concept in addition to need for an energy audit for parameters related to building envelop.

2.3. Sensors Based Energy Assessment of Buildings

Different strategies exist to obtain operational data of buildings like; sensors, in order to enhance the quality of building performance assessment and ultimately reducing the performance gap. Sensor based energy assessment is a measurement based method which involves the collection of the desired data through the use of sensors. Sensors can also be customized according to the data requirements. Sensors usually required include for parameters such as; temperature, light intensity, occupancy, voltage, current, humidity, pressure etc. These are minimum sensors that can help in collecting both operational and climatic data parameters.

2.4. Energy Audit

An energy audit is an assessment of a facility that provides insight into current energy consumption of the building and to spot what and where cost-effective energy efficiency measures could be applied. There are types of energy audit: 1) walk through audit, 2) Detailed - diagnostic energy audits. Energy audit checklist is made according to the data requirements. The type of energy audit depends on the following factors:

1. Industry used its function and types
2. Up to what extent depth of the study is required
3. The size of the audit and the desire of the study reached

The research conducts physical audits. Instruments are used to calculate energy variability in equipment and devices, identify electrical faults, locate energy losses in the building envelope, detect water damage and shape heat maps etc. The physical profiling of the house is conducted and technical data is collected that includes monitoring and measurement of the temperature and wind speed with the help of instruments.

2.5. Living Lab Concept

The term 'Living Lab' is in use for over 20 years that focuses on involving users in development and innovation Krogstie, J. et al. (2013). Living lab concept was first initiated by a European project named SusLabNWE (Sustainable Lab North West Europe) which helps in building Living Lab physical infrastructures, as well as approaches and strategies for user participation, across North West Europe Herrera (2017). Living Lab

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involves the co-creation and experimentation with the real users in the evolution of innovative solutions, services, products or innovative business models in real life environments Herrera (2017). In the context of energy efficiency, it can also help in investigating impact of ICT based user interface on behaviour change towards the energy efficiency.

2.6. Application of Living Lab Concept

The living lab concept has been in application for a decade. Many researches has been based on living lab. Some of the research studies are discussed below;

1. In 2013, middleware-based smart building living lab was deployed in 18 rooms of a three buildings in the university campus of Italy and an office building in research campus in Germany. The LinkSmart middleware was adopted and the living lab concept was applied in order to create building in research campus in Germany. The LinkSmart middleware was adopted and the living lab concept was applied in order to create the flexible software infrastructure for smart energy efficient buildings. It was created to be an open and extensible system that will develop into an energy management system of an integrated building, using user-centred and iterative living lab process. The interoperability between the technologies and system and the role of the end users that includes; occupants and building managers etc. are the real issues involved in such smart buildings. Altogether following technologies were adopted in the living lab (Jahn et al. 2013):
 - a. EnOcean technology is used to control lighting and heating as well as monitor presence, window states, temperature, and appliance and light energy consumption.
 - b. Monitoring devices
 - c. An Arduino-based experimental setup for detecting presence and window states.
 - d. Plugwise4 smart plugs for calculating appliance energy usage.
 - e. Hardware to control lighting and HVAC
 - f. Setup having a Siemens Desigo BMS is included.
 - g. Additional data regarding ambient conditions and device power usage is collected using TelosB WSNs and Plugwise smart plugs

By providing feedback, their aim was to increase the acceptance of smart buildings and foster research involving users and permitting transparency. Now they are validating sensor computations and modifying the control strategies to the quirks of deployed sensors.

2. In another research, in 2013, the FormIT Living Lab methodology was applied having three iterative phases to the buildings in the partner countries including Norway, Sweden, Denmark, Lithuania, and Iceland. The objective of this research was to establish general requirements across several countries to information systems that supports reduced energy consumption in houses by describing a living lab approach. The first phase in FormIT was finding a need finding and generating an idea of energy efficient solutions that included user, public authorities and developers of energy saving solutions, second was development of concept and testing, and third was development and test of final system. In third phase, private businesses deliberated development of solutions by deciding on which solutions they could incorporate into their own current energy saving service. The co-partners then developed solutions and tested them in real life situations with user-groups in different partner countries. The user experience was then assessed and documented and questionnaire was made which concentrated on feedback from the users about the impact of the final solution on the energy usage and the solutions' effectiveness. The results were then compiled which included, ICT usage, current situation, actions, and future solutions. Actions to save energy included; low energy light bulbs, triple-glazed windows, heat pumps, motion detectors for light, doors that automatically open and close and, sensors which work on quantifying needed heating and cooling. Depending on the number of people present in the building and dishwashers to energy graded ones. Through the developed solutions users were (Krogstie, J. et al. 2013):
 - a. Able to control some specific devices in their houses and see the results immediately on their smart phones phones by using existing Wi-Fi as transport for AMS meter readings.
 - b. Use an app, which shows real-time energy consumption and other power statistics.
 - c. Smart house technology that enabled user to control over power devices through the mobile app.
3. Another research, in which smart building "GreEn-ER" is used as living lab. It is a new building in eco-city in Grenoble, France, supporting teaching and research in the discipline of sustainability. This paper presented energy key factors and the capability of the building structures to improve sustainability. GreEn-ER is a 6 floors building comprising a space area of 4500 m² per floor for teaching / research platforms (Delinchant et al. 2016). Its design included application of a number of sustainable ideas. These sustainable measures in experiment comprised of energy improvement measures, cooling strategies that

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use natural convection, data server room releasing calories were reused to heat a facility, and forced convection in offices, low temperature supply and dual flow ventilation having high efficiency recovery, automated HVAC, lighting and blinding dependent on local sensors of CO₂, temperature, illuminance, and inhabitancy, moderate energy use i.e. restricted cooling, no boiling water in restrooms, switching of power supply, moderate water use for example two-fifth of the water utilization is from rainwater and green rooftop. It predicted the total primary energy usage to be less than 2200 MWh / year that corresponds to 110 kWh/m² (Delinchant et al. 2016). In GreEn-ER lab, PREDIS-MHI platform is an energy system with an area of a 600 m², specifically designed to reach zero energy buildings. Further measures were taken to make it a zero energy building. Installed photovoltaic panels on vehicles roof and building roof having a capacity of 20kW, combined heat & power (CHP) that may also heat the platform, electrical productions such as a fuel cell, storage capabilities, 50kWh stationary battery and optimal control solutions based on predictive models for both electrical and thermal equipment were tested in the living lab (Delinchant et al. 2016). Dimmable lighting, HVAC, blind, electric plug load efficiency, blind and switch were some of hundred measuring points and control that had been taken. These communication protocol measures were web service based that enabled interoperability. Co-simulation and predictive control were carried out and optimization techniques were also adopted. In the living lab, automation of energy management and users were integrated and occupants were able to define set points such as temperature, CO₂ concentration, luminosity, heating mode. Users were provided with several defined workshops for developing ideas, innovative products, and solutions. The workshops were end-user side view and helped integrating smart grid essentials like; decentralized renewable energy integration, energy peak reduction, and end-user needs like comfort, sustainability, and economy. The results were based on energy consumption aligned with occupant comfort criteria, and peak power. This helped in identifying scientific results such as; energy autonomy of building or micro-grid, real-time energy management, multi-flow energy optimization.

4. Sensor Based Living Lab Assessment

Living labs can be described in a variety of ways and serve a variety of goals. The concept of living lab surrounds in the same fashion as Figure 1 depicts.

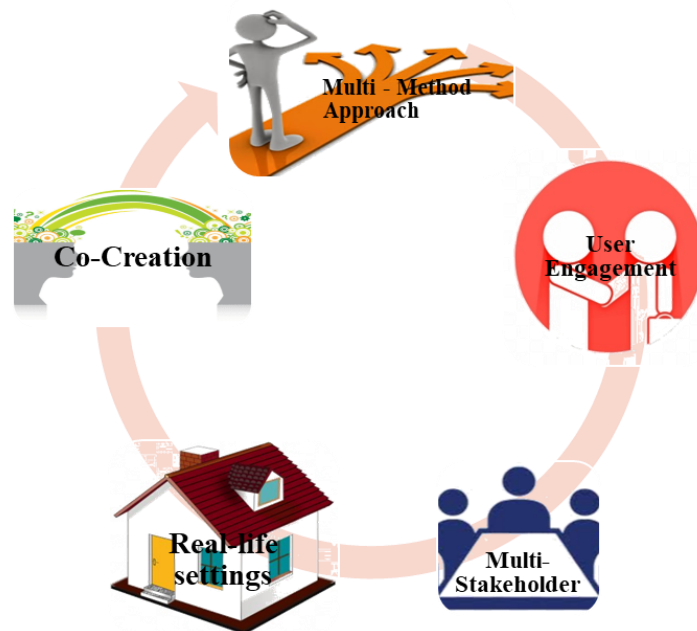


Figure 7 Living Lab Concept (adapted Aversano, P., Baccarne, B., Schuurman 2019)

4.1. Multi-Method Approaches

There is no single living lab technique; instead, every living labs mix and personalize several user-centered, co-creation methodologies to best suit their needs.

4.2. User Engagement

It is the essence of living lab concept. Without the involvement of user the purpose of living lab is dead. It distinguishes the experiments with those which have been done in closed desired controlled environment.

4.3. Multi-Stakeholder Participation

The main actor that plays vital role is user, but the participation of other stakeholders, public and private sector, academia and people is also crucial to handle.

4.4. Real Life Setting

This is the core characteristic of the utilization of living lab as it give the real time knowledge and data to gain a thorough overview of the real time scenarios.

4.5. Co-Creation

The living lab concept aims for mutually beneficial outcomes as a result of all stakeholders participating actively in the process from the very beginning stage of the projects.

Method to establish a living lab depends upon the nature of experience types, namely: cultural, economic, emotional, empathically, social and technological (Pallot and Pawar 2012). Then they are further segregated into different information rich small packets. Herrera in 2017(Herrera 2017), explained the concept of living lab in detail with the help of following Figure 2.

Figure 2 depicts the three levels of integration suggested by Herrera in 2017 (Herrera 2017), using a three-ring metaphor of a funnel's top view, beginning with an extended surface representing the context under study's complexity, moving deeper into more specific and narrow areas of practices, and finally touching on specific sustainability and human aspects of strategies

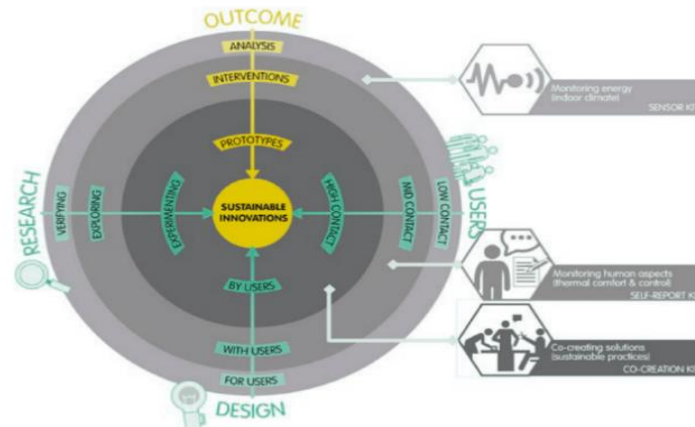


Figure 8. Mixed Approach for Sustainability Lab (Krogstie, J. et al. 2013)

Four axes show the different sort of user involvement as USERS, design strategies for as DESIGN, research targets as RESEARCH and innovation and solutions as OUTCOMES. To characterize each level of integration, these axes constitute quartets of [User, Design, Research, and Outcome] configurations. Consider the following scenario:

4.6. Outer Ring

In this scenario there is intermittent or no user involvement in the data collection that represent the basic needs of the client. Sensor systems are used to collect continuous data and cloud-based database is generated. The knowledge generated describes the long-term resilience of present behaviors, and creation is facilitated by the identification of new possibilities and their potential impact. The outcome is a strong analysis typically more useful for research and development in addition to interventions for client.

4.7. Middle Ring

In this scenario, relatively more rigorous and active participation of user is required in data collection due to which the deeper insights of the user needs can be gathered. The knowledge generated provide the ways to different alternative resilience behaviors. The outcome is more suitable for potential interventions by users, and are at just exploratory level for researchers.

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4.8. Inner Ring

In this scenario the user collaborates as the most active participant in data collection. The outcomes help in developing prototypes with some validated impact on sustainable practices, hence, can serve as mere as experiments for researchers.

5. Proposed Concept in Practice

The proposed concept in practice i.e. living lab concept for sensor-based energy performance assessment of houses is aligned with outer ring (Figure 2) in which the intermittent user involvement is required, designs are for users, verification is done as research and analysis can be provided as outcome.

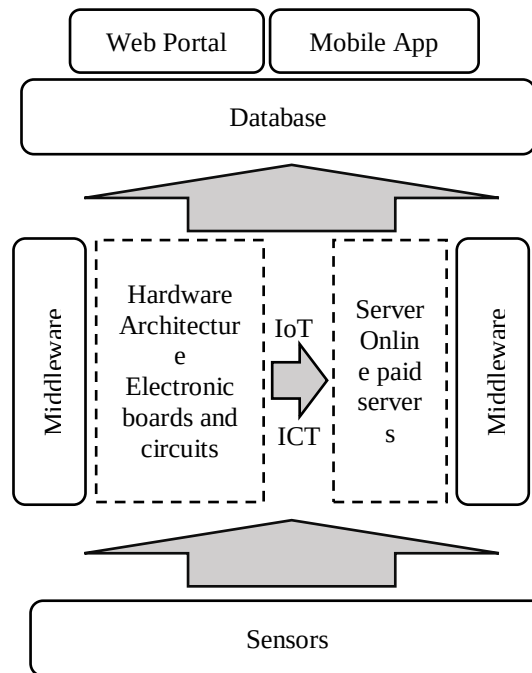


Figure 9. Living Lab Concept using Sensors

Above presented schemes (Figure 3) is a bottom-up approach. Three sets sensor-based system that include; temperature, pressure, humidity, light intensity sensors for indoor measurement, and weather station at top of house/building providing same parameters externally is used. Additionally, weather station also provides wind speed. And watts per square meter that can be used to measure solar and wind energy generation potential of a roof top. Data collected from sensors that give the internal climatic condition in the form of temperature, humidity, atmospheric pressure etc. to depict the real time scenario of the house. This information is recorded through the sensors then send to hardware architecture. Now, it transferred to online paid server using Internet of Things (IoT). After transferring to the server, data is displayed on web-portal or mobile app and data base is generated.

A web-based dashboard is designed to collect data feeds from sensor, the frequency of which can be adjusted by the user from 20 seconds to 30 minutes interval. A snapshot of results from dashboard is shown in Figure 4. After creating the database through this approach Energy performance assessment of a house has been done which shows that the real time data gathered created the most accurate results.

6. Conclusions

1. IoT provide immense help in furnishing the requirements of living lab.
2. The living lab concept provide the real insights of energy performance of houses as compare to the energy performance analysis provided by modeling software.
3. ICT and IoT plays major role in completing the living lab concept.
4. Data collected using living lab approach give the chance to model the houses more accurately. It offers the provision of increasing the information in Level of Development (LOD). LOD500 is the highest level of information that can be provided in modeling software which requires the as-built conditions and scenarios. Light intensity, power density and occupancy schedule are the key factors. When these key factors were incorporated in the modeling of house, results of energy analysis vary 70% approximately

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from the previous results without the information collected through living lab. It can be concluded that the data collected through living lab increases the LOD which ultimately improves the results of the energy analysis through modeling.



Figure 10 Dashboard for Sensors

7. Acknowledgment

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Effect Of Leadership Style On Employee Performance

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Abstract

In this study it comes under the observation that there is a big effect on employees through Leadership skills. These effective practices make stronger to organization and another aspect with this observation is to clearly justify the effect of styles in a different way like Democratic, autocratic, and participative style on employees for enhancing their performance. The main objective with great Guidance it was analyzed that obviously autocratic style has much effect on employee performance inside the organization. On other side the way of participative is quietly good for further efficiency raising up. This study is based on qualitative approach, whereas Secondary research is on prior behalf. The reason behind this study is to have further discussion widely on employees' performance as the readers can get bunch of knowledge about it. In secondary research it will be added to put data via reports general information magazines and general Journal. Making widely valuable to this article it came to know that there is greater impact of Leadership style on employees acts the role of behavior and its performance. Democratic style is highly useful beneficial for employees at all times while the participation style is also beneficial for employee's performance on a long-term duration Few further recommendations are under the discussion in this thesis.

Keywords:

Democratic And Participative, Employees' Performance ,Leadership Autocratic

1. Introduction:

The primary goal behind this research was to measure the impact of Leadership style only on employees' performance. Here in the end will focus directly on the employees. This section describes the main contributions for this research, including (historical perspective, theory, and concept). All these sections mainly describe the problem statement, objectives, purpose, research question, hypotheses, and scope of research.

1.1. Historical Perspective.

Over the many years it comes to know that the Leadership has every time supported and created well morally, professionally, ethically, civilized effect on employees' performance to manage appropriately their issues, problems, which are occurring inside the organization every next day. Latently with the passage of time the trends have been changed not accordingly all are followed like traditionally now a day, Human Resources Leadership a solemnly unit is opened in every sector or in company to have a complete focus, concentrate on employees' performance. This method is related to Leadership style and effect on employees' performance just because to re-improving activities of valuable assets which are often engaged in organization.

(Kenneth 1998) states that Effective Leadership is usually very important for the organization to increase its demand value as they could operate well. Many types of styles are adopted only to keep maintain the atmosphere of employees and performance Administrational condition and cognitive way of approach exactly attracts to the better act through employees and making sure to keep them satisfy for raising up the level of well discipline along with performance. The consequences came as due to lack of cooperation, contribution appears as less efficiency of employees so the main matter a good direction does really affects to take up the greatness observation of employees' activities previously it seems like poor quality was on a peak level just because of the due not dignified upon employees. Leadership was engaged to have only and only focus on admin branch not utilizing employees in appropriate not meeting with the need wants of employees. Now a days in every company or every sector is looking forward to fulfilling the required needs of employees.

1.2. Conceptual Perspective:

In this survey, there is a distinctive Leadership style of entitlement such as autocratic, democratic and participative as a free factor, and employees' performance as a dependent variable. Based on their relationships, construct a theoretical model to examine which Leadership style is generally appropriate for the promotion of association representatives. Therefore, employees' performance is considered functional, fulfillment of certain

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obligations, compliance with time constraints, team engagement and completion of departmental goals. The above should foster a skilled, professional, persuasive investment and a strong relationship of authority.

The suffix of these two terms (Leadership and employees' performance) must be proven by style and method in order to produce effectiveness. In a survey, these variables are active and are undoubtedly, Carter (2008) Leadership is characterized as the ability to use administrative capacity to coordinate the implementation of measures and to achieve proposed hierarchical goals by arousing, triggering and persuading groups.

1.3. Theoretical Perspective

(Fred 1995) Gives an idea of Fiedler's Leadership contingency version concept, where he proposes that the overall performance of an effective employees depend on the correct set between. The Leader's Upper Limit Potential depends on the overall situational factor to the ability of the leader Desirable fashion, behavior, and a number of talented employees Fisher (1995). The concept demonstrates that leaders must take the most appropriate approach to the situation and stimulate the overall performance of their employees without delay have a greater understanding of Leadership including persuasion and clarification. In addition to limiting the ability to identify, affirm, and improve the organizational values expressed by supervisors.

Leadership expertise technical skills cultural awareness and different expertise and abilities It is not enough for a leader who can devote himself to public service. Strong supervisors are obliged to provide staff with guidance and expertise to guide them towards higher overall performance and lead them to professionalism to maintain quality. Taking care of all crew contributors is one of these first-class obligations. The emergence of managed cleanliness requirements promotes moderate and mature values.

1.4. Statement Of Problem

The overall performance of the employee includes the performance of the described responsibilities. set time for assembly employee competence and work efficiency and performance Organizations of all types need a strong Leadership style that can boost overall employees' performance. Some of the problems faced by non-governmental organizations include passive innovation, low productivity, and failure to achieve overall performance goals. This type of problem arises because the strategic intervention of a particular Leadership style turns specific conditions into expectations. due to immediate problems This has become an issue that continues to affect the overall performance of the employees. That's why looking at a pleasant Leadership style in which surveys can inspire a person's overall performance. It is believed that competent employers come from sponsors or leaders of commercial enterprises. The strong Leadership concept is also based on world-class technology. Employees also believe they may need a heart pacemaker. And they must know that they are no longer at their peak. Must be a leader, but they need to be strong. Therefore, they need a strong boss who can bring humanity closer to adapting and improving overall efficiency.

1. How does a pacesetter carry out beneath Neath the attention of powerful overall performance of employees' and firm?
2. How does leader's effectiveness adjustments the overall performance?

1.5. Purpose

The purpose of observation is to evaluate the impact of specific leadership models (autocratic, democratic, and participation) on the overall performance of employees.

1.6. Specific Objectives

Study on the effectiveness of objective and experiential leadership. Learning without reason is meaningless. Part of the struggle is the introduction of best practices in leadership.

1. To discover the Leadership patterns that contributes to worker overall performance.
2. To provide an explanation for the connection among the powerful Leadership patterns and overall employees' performance.
3. To realize the importance of Leadership patterns withinside the worker overall performance.
4. To increase the version that suggests courting amongst exceptional kinds of Leadership and worker overall performance.

1.7. Research Questions

1. How effective is the Leadership style on employee performance?
2. What are the consequences of effective Leadership?
3. What is the relationship between participative Leadership and employee performance in the organization?
4. What is the relationship between democratic Leadership style and employee performance?

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5. To what extent does authority affect the performance of employees in the organization?

1.8. Significance Of The Study:

Therefore, the end of this article will understand the existing ideas for creating information and data. Every planner can use this information and data to produce systems, schemes and plans that will deliberately lead to anomalies. Environment. up to the present. This survey will be useful to different analysts who can focus on understanding the compelling idea of Leadership by meeting the views expressed in the target area. The importance of this research is that different experts may choose to use the results of this research in future studies that will have a significant impact on society. The results of this survey can be used in different survey results and ultimately help understand business changes. Current research shows that it is powerful in many ways. Added to information gathering as the current area is being investigated for anomalies in Pakistan. No research has been found on the impact of Leadership methods in expanding Pakistani employee performance. Fully answer long-term questions about how to improve the performance of leaders.

1.9. Scope Of The Study

The research is about exploring autocratic, democratic and participative styles promote the performance of employees', including meeting characteristic obligations, complying with time constraints, and meeting departmental goals.

1.10. Literature Review

What is the Leadership here? What is the Leadership style? He then clarified the hypothetical structure and explained the impact of the three styles of authority (participatory, totalitarian and majority rule) on the implementation of the performance of employees.

1.11. Leadership

Leadership is the process by which a leader influences the behavior and actions of others in order to achieve a clear goal in a specific situation. Leadership is the ability of a supervisor to motivate his subordinates to work with determination and enthusiasm. Leadership can be defined as the ability to influence global acceptance of goals. Leaders need a vision for the future and the motivation to pursue and realize their dreams. As indicated Adair (2002). "Leadership is the capacity to convince others to look for characterized goals excitedly. It is the human factor which ties an assemble and to work on their presentation and to guide them towards objectives"

(Kourdi n.d.) proposes that Leadership is about managing and adapting to change. Emphasis is placed on a longer-term perspective and a higher perspective. Instead of continually trying to make sure you're actually facing the challenge, and focus on the person and their qualities. Not just the main focus.

(Collins 1995) Publishes an article on outstanding Leadership in the Harvard Business Survey. In the article titled "Leadership", "Most convertible executives have a combination of personal humility and confused professionals will... They are shy and cruel. Their core is strengthening rather than controlling employee productivity improvements.

1.12. Leadership Style

Leadership Style Business Authors Daniel (2002) Categorize Different Leadership Styles. They Propose That Leadership Styles Can Be Clarified, From Totalitarian Regimes To Justice To Inclusiveness, To Demonstrate The Power Of Leaders And Representatives And The Power Of Choice (Figure 1).

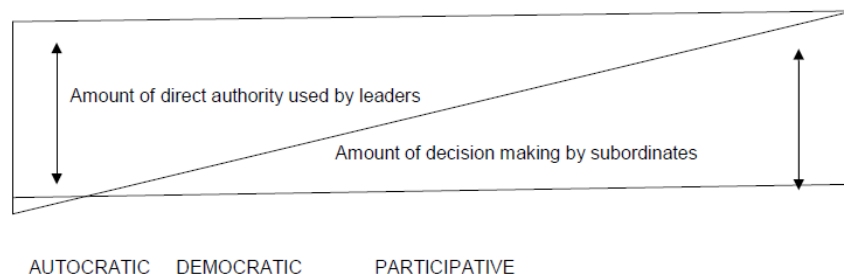


Figure 1: Leadership styles.

1. Autocratic Approach

The autocratic style is explained by the rational "I tell." autocratic leaders direct each employee. This can give the company reasonable advice. But it can cause Leadership to underestimate or ignore group participation.

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in any case An authoritarian approach is appropriate in some situations. This is important when a business is facing an emergency or a serious issue that requires a quick response.

2. Democratic Approach

Democratic approach defined by "I share" logic. Selection is made within the group and each department has the same source of information. Martin is head of Tesco's UK training and competence development. People have a set of obligations related to cycles and norms. When making financial plans, Martin can use a Democratic approach.

3. Participatory Approach

The proactive, participatory model involves everyone on the team to identify key goals, and create technology or systems to achieve these goals. In this view, participatory Leadership can be viewed as a form of Leadership, which relies heavily on leaders as facilitators It's not just a claim or a mission. This well-designed positive pattern can be applied in any work environment. Volunteer Association and an amazing family form.

One of the main advantages of participatory Leadership is that Interactions will consider promoting other executives, that may serve the association in the near future Because leaders who like this style bring a dynamic connection to everyone on the team. Thus individuals are able to share their creativity and showcase talents and abilities that are not regularly seen, which is a representative performance in the last event Disclosure of these confidential sources will help the current group's profits, and at the same time informing the association that individuals in the group should be free to develop or apply additional professional knowledge or skills in the future.

While everyone has their own style of leadership, the best chefs adopt a style appropriate to the occasion. They will consider several variables to come to a conclusion:

- a. Is a mission the foundation of a business? Do I have to choose immediately? How does it affect the business?
- b. Does the group have the right abilities and assets? Are you familiar with the selection?
- c. What was the previous standard for customization?

1.13. Theoretical Framework

Fred (1995) proposed the Fiedler Leadership contingency model theory. He suggests that employee efficiency depends on proper black and white matching. A leader's Leadership abilities depend on contextual factors, including Leadership skills expected pattern and behavior and abilities of employees. This theory believes that leaders should use the most appropriate form of action and improve employee performance in a timely manner.

Effective leaders are responsible for providing advice and sharing information so that employees can perform better and are experts in maintaining quality. He is also responsible for all team members and has high responsibilities. Introducing clear Leadership standards fosters mature core values, roles, and responsibilities. The environment affects the duties that leaders perform and how they are performed.

According to Carter (2008), There are about three types of Leadership styles. He also describes the different aspects of each style that greatly affect employee productivity.

1. Autocratic/Leadership:

Both of these conditions describe the type of leader who gives the orders and is expected to obey immediately without argument. Plans and policies are made independently of the team. Future reasons or intentions were not disclosed when the order was issued. Absolute leaders are not part of them at all, they only suggest.

2. Traits of autocratic style:

All decision-making powers are their own. Requirements that cannot be met excessive discipline and punishment Don't let others question your decision or authority. It is not clear that you have the ability to criticize opinions, easily offend and offend him/take advantage of others as the focus of action. It is very competitive and useful in the short term.

3. Democratic/Passive:

The leader of the Democratic style, the best theoretical leader, made no suggestion. But ask for the opinions of the group. The group was left to make democratic decisions and adopt a "rubber stamp".

4. Participative:

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Participatory Leadership is a style of Leadership in which employees are involved in the decision-making process. Dedicated leaders use this information to make decisions about group opinions. The group always understands the future. And changes to long-term policies are allowed to be discussed and proposed.

1.14. Effect Of Different Styles On Employee Performance

As pointed out by Marion Rush and Cole, partner leadership style has the most positive impact on employee performance. In this case, employees will feel efficient and confident when working and making decisions. Leaders have decision-making ability only when employees feel that their work and decision-making ability are insufficient. Democratic employees have a certain degree of discretion when completing tasks.

2. Research Methodology:

Researchers will examine this issue with explanatory perspectives and investigations using an interesting method, using group meetings and interviews. To illustrate this interesting survey, David, B. (2004) advises analysts as he expresses: A sample research technique is to collect information about the current state of existence. The rationale for using this strategy is to conceptualize the situation that exists at the time of the audit and to examine the impact of Leadership style on employee and organizational performance.

2.1. Data Collection:

Secondary Source: The second survey will be coordinated. The reason is that you can choose to have a full conversation with your readers. This will help them understand the problems and factors. Related. Again, the resources in the second survey will include past research reports, papers, journals and diaries. The findings contained in the diary and the information contained in the book will be used for secondary surveys. Translations are guided which can be interpreted in a qualitative manner.

2.2. Testing Unit:

The Executives clerks/non-clerks' staff and other employees of Non-governmental organizations of Sukkur District sample unit of my research.

2.3. Hypothesis

(H₁): There is no significant relationship between the effective Improving Leadership style and employee performance

(H₂): Democratic Leadership style has a significant effect Employee performance

(H₃): The style of autocratic Leadership has a significant impact on employee performance.

(H₄): Participative Leadership style has a significant impact on employee performance.

2.4. Research Model

The model of the research (with independent variables, dependent variables, Leadership style) is defined in Figure 2.

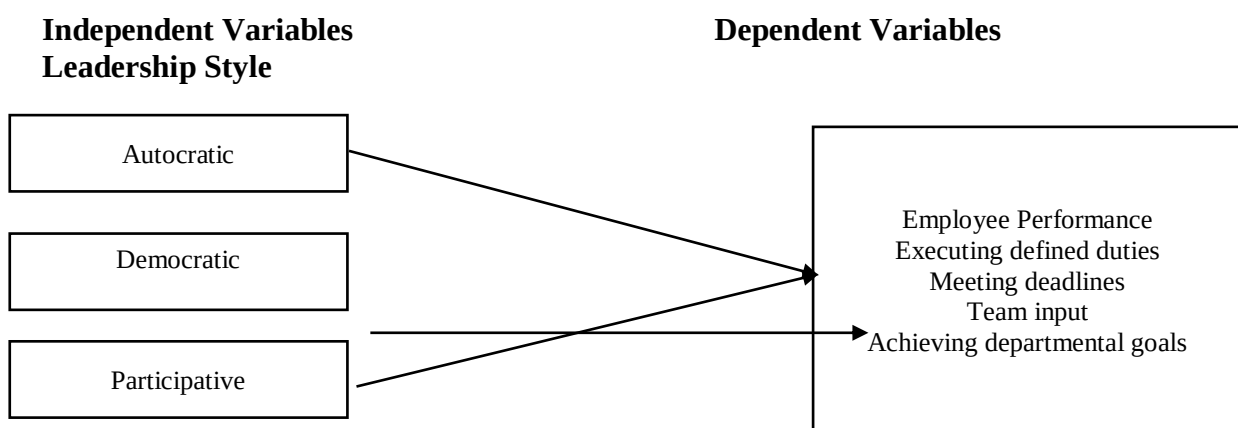


Figure 2. independent variables, dependent variables, Leadership style

3. Data Analysis And Discussion

Leadership style has a significant impact and is conducive to some of the world's largest private companies and corporations. These styles affect everyone. From senior managers to new competitors, employees and startups have built a corporate culture that influences employee engagement and the success of scheduled project managers.

Leadership style indicates behavior and elimination of pioneers in Leadership and governance. This is the result of the character, understanding, thinking, and judgment of the leaders. The way well-trained professionals speak has been further developed to understand the nature of the Leadership. Various situations require unique Leadership styles. When short-term understanding and quick work are required, an autocratic Leadership style may be best if the appointed leader has more insight or ingenuity than the other members of the team, although it is very dynamic, and degree adjusted. with the same talent in the team A more inclusive and democratic model could be more successful. This style should be the most successful one based on the team's goals. and at the same time aligning the interests of team followers and colleagues under the guidance of a strong leader.

3.1. Autocratic Style

(Milgron, P., & Holmstrom 1991), also known as the authoritarian Leadership, said the autocratic style was clearly a feature of the distinction between Leadership and employees. The Leadership of autocratic chose to represent almost zero tolerance. These Leadership are more confident, more confident, and better at the dynamic imperatives of the system plan and the work of their fellows. While discoveries show that Leadership vanguards were not as innovative as modernity. trendy. Adair (2005), only one person has full position and control over supporters or employees. His choice will be seen and considered extraordinary. Guides should never be unraveled by anyone, nor hindered by anyone. It has regulations for every achievement, and its devotees are limited to studying or following principles. Therefore, Leadership control it completely. This is valuable when quick and fast selection and performance is required.

(Dawson 2002) said the Leadership style can show extraordinary results in a short time. However, in the long run, unreasonable use of electricity will degrade efficiency. People either become exhausted, disappointed and leave, or they become distracted by the monotonous work of the murmur drums without creativity and progress, or simply become unmotivated.

(Heneman, R., & Gresham 1999) are under the Leadership of the dictatorship, all their motivations combined and, like a tyrant, in the hands of the vanguard. These Leadership do not seek any ideas and motivation from devotees. It is not effective because it is not a solid source of inspiration for managers and employees. This style allows for fast dynamics. These Leadership will not take any advice from their workers. They recognize that Leadership should only make one decision, and delegates should only follow them and may or may not follow. This type of Leadership is not very flexible and may be a reason why delegates lost their inspiration.

(Ittner, C. 2002) autocratic style of Leadership led to unstable discussions, so the creativity and Leadership of the representatives became prohibitive, and all this involved day-to-day monotonous work. Because Leadership have power, there are opportunities to abuse and distort workers. This style limits correspondence and social interaction in the workplace. There are warm workplaces, everyone needs a very polite and informal organization. If the assembly or organization is supported by autocratic leaders, it will also cause many conflicts.

3.2. Democratic Leadership Effects

According to Ittner, C. (2002) Milgron, P., & Holmstrom (1991), this style is often seen as an advantage by most organizations. This style tolerates and earns the contribution of a single colleague while allowing Leadership to provide guidance and assistance to the center. However sincere these Leadership were in clamoring for the workers' meeting, they did not insist on their activities and mandates.

(Heneman, R., & Gresham 1999) promoted sharing of responsibilities, designated activities, and ongoing discussion under most rule styles. In this style, the leader provides opinions and suggestions on every important issue and choice, successfully delegates tasks to subordinates, gives them full control and a sense of responsibility for those causes, and encourages others to be acceptable Leadership. employee development. This encourages employees to take more responsibility for breaking down goals and implementing them in a way that meets time constraints.

(Kirega n.d.) Evaluated employee perceptions of senior and senior leadership teams, pointing out that this style focuses on harnessing the skills, experiences and ideas of others. However, for the leader or director who adopts this style, the end result is still in the hands of the leader. The initial contribution of those affected is commendable that they will not make a major choice if they do not have appropriate recognition and representation obligations. This Leadership style is suitable for current and long-term presentations and can be used for commercial projects.

Debashis, C., & Senge (2002) Suggestions for when Lenovo requires imaginative critical thinking Introduce an association or office to prepare individuals for influential positions and careers every day. This format provides certainty to delegates. This will help them meet time constraints and department goals for effective data clustering.

3.3. Participative Leadership Effects

(Waggoner n.d.) said it looked like a successful election, compared to other general styles, appointed leaders rarely make decisions. In most cases, leave it to the employees. These leaders assign responsibilities to employees and advise loyal colleagues.

(Graver, K., & Austin 1995) It means that the participative model is temporarily useless. in any case This type of link is more useful for linking in longer time frames. This benefit is enhanced by greater accountability and delegation of business and department goals.

(Northouse ,2001) Northouse believes in participatory initiatives: Leadership invites and encourages colleagues to play an important role in the decision-making process. But the decisive motivation lies in Leadership. Will the leader recommend employees? More importantly, how do you do it? In turn, agents communicate their experiences, ideas, and suggestions to leaders. The main advantage of this leadership style is that it can impress successful leaders and talented employees. It stimulates imagination, opens up the workplace and continues to support creativity. The only drawback of this driving style is that it is particularly boring.

Mullins (2002) Kerr (1975) participatory Leadership, takes into account the progressive interaction and behavior of additional Leadership who may serve unity in the future or at some point in the future. Since Leadership supporters who support this style state that this pioneer supports dynamic contributions to the workers in the group, individuals rarely express their imagination, and the expression does not under any circumstances indicate their abilities and talents.

4. Conclusion

As Myron Rush and Cole explained, participatory leadership styles have a more positive impact on employee performance. In this situation, employees feel empowered and confident in doing their job and making different decisions. In an autocratic style, leaders have the right to make decisions only when employees feel inferior in their work and decision-making. Democratic-style employees have a certain sense of accomplishment to get their work done, so their performance is better than an authoritarian style.

4.1. The Autocratic style is appropriate

When new employees are unfamiliar, they don't know enough about their job
If employees often abuse their authority
When an employee violates company regulations
Be the only person responsible for decision making and implementation

4.2. The Democratic style is appropriate

When the organization needs to solve problems positively
When the organization conducts a planning meeting for the operational progress of the department
When the organization trains people for leadership roles
When you need to do your daily organizational tasks well and efficiently

4.3. The participative style is appropriate

When the organization has competent and talented team members
When planning a meeting to improve the company or department
When the company holds an evaluation meeting
When you motivate the best performers in your organization
When you need an innovative and creative job

4.4. Recommendations

- a. In admire of the above conclusion, the democratic leadership style in non-governmental Organizations might similarly empower their employees via way of means of growing groups and in accordance a few degrees of strength and authority to their employees. In this way, employees might ignite their potentials, experience a part of an organization and carry out maximally for the organization.
- a. Following the second one conclusion, the non-governmental Organizations might instantaneously reduce the autocratic leadership practices. Hence, non-governmental Organizations might suggest for the higher leadership patterns that suites distinct conditions so that you can lessen the dominance of autocratic

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leadership until in conditions in which it's miles necessary. The researcher similarly endorsed that it turned into crucial for the non-governmental Organizations to expert overall performance hints that create an experience of duty to employees.

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Exploratory Analysis of Entrepreneurship Education in the Jamshoro Public Universities: A Descriptive Study

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Abstract

The purpose of this study is to explore entrepreneurship education courses offered by public universities of the Jamshoro higher education institutions (HEIs). It examines the scope and the existing status of entrepreneurship in the Jamshoro public universities. Data were based on secondary data taken from official websites, prospectus, departmental reports and universities' policy documents of the public universities of the Jamshoro Higher, included three public universities by examining their curricula and exploring the status of entrepreneurship of the selected sample from these universities. The results of this study indicated the public universities of the Jamshoro higher education city, just one core course on entrepreneurship was offered to some departments. Furthermore entrepreneurship programs were extremely rare. As a result, this research may encourage policymakers and universities to develop an effective and appropriate syllabus to fill the gap in existing curriculum of not only entrepreneurship but other courses as well.

Keywords:

Entrepreneurial Ecosystem, Entrepreneurship Education, Entrepreneurial Universities, Public universities, Jamshoro higher education city

1. Introduction

Over the last 15 years, the global economy has created different methods to utilize the youth talents towards the creations of new enterprises Hitt and Reed (2000). Today's, Career choice is a big development challenge for youngster and difficult to decide which career path should take and pursue desired career, but it is an important decision for every youth. Graduates of HEIs are facing difficult challenges in placing themselves in their selected career. This is due to the rising job challenges and employers' expectations, where HEIs graduates are not evaluated just in term the academic qualifications perspective, but also in the term value added skills and capabilities Iswati and Hastuti (2021).

Nowadays unemployment is one of the serious socioeconomic challenges of many countries including Pakistan. The unemployment rate has become a national concern and every year the number of unemployed graduates is increasing Setiawan, Fattah, and Puspitaningrum (2019). However, Entrepreneurship is remedy to reduce the rate of unemployment among the youngster, especially among the (HEIs) higher education institutions. Today's entrepreneurship is mostly associated with bearing risk and innovation. The most important pioneer in the field, Joseph Schumpeter, views innovation as a demanding link between economic growth and entrepreneurship Śledzik (2013). Entrepreneurship is the one of the global growing topic areas, with increasing interest due to its ability to connect the practices of current business with theories of academic. Entrepreneurship education gives students a deep understanding of business, including its purpose, structure, and how it interacts with society as a whole. As a result, it aids in the transmission of abilities that may be taught through an educational system, which can assist individuals build an inventive strategy Klapper and Love (2004). Entrepreneurial education should begin earlier in the educational system, namely at the school level, according to Kroon and Meyer (2001) since it strengthens and prepares students to pursue a career in business after graduation. According to Amanuddin Shamsuddin et al. (2018), students are more expected to start a business if they had previously engaged in some form of entrepreneurial activity. However the according to previous research, 40% of students who took entrepreneurship as a course went on to start their own business/venture. Entrepreneurs are seen to have the ability to produce the economic growth of the country through creating the jobs for themselves and others. If someone who take entrepreneurship as their career, they can attain financial independence and also contribute to the economy through the job creation, innovation and development & growth.

Many nations have begun to incorporate entrepreneurship education courses into their college and university curricula Fayolle, Gailly, and Lassas-Clerc (2006). While acknowledging the importance of entrepreneurial education in the promotion of the country's overall growth and progress, Pakistan's Higher Education Commission (HEC) has taken the initiative to establish centers of Entrepreneurship and Development

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across Pakistan, especially in higher education institutions. In Pakistan, there are total 135 universities 61 are private and 74 are public and 1,993 universities affiliated with the Pakistan Higher Education Commission (SIU; HEC, 2012; HEC, 2013). On the other hand, universities lack entrepreneurial staff and faculty; as a result, only a few universities in Pakistan, such as the Islamic College, Lahore University of Management Sciences (LUMS), and Institute of Business Administration (IBA) provide entrepreneurship-related courses in their undergraduate and postgraduate programs. In addition, the Institute of Business Administration (IBA), in collaboration with other public sector institutions, is working hard to develop a Centre of Entrepreneurship. According to the 2016 National Business Accreditation Council, 117 business universities provide courses on how to start and run a business; nevertheless, the schools are failing to meet the demands of students and the business sector. Entrepreneurial education is lacking in Pakistani colleges, and it should be introduced as a separate specialization under Management Education umbrella. Since a result, suitable methods must be followed, as entrepreneurial education would offer stability and sustainability to Pakistan's economic development.

There are three basic ways in which entrepreneurship fosters advancement and growth. The first step is to raise awareness and convey information, which is a dynamic instrument for the country's economic advancement and growth. Organizations must improve their capacity to learn new tools and accept ideas from a variety of groups. The second approach to improve in entrepreneurship is to increase enterprise and competition in society, which helpful in the financial advancement. The number of organizations is growing every day, which is accelerating the creation of new ideas and competitive innovation. Various groups may be able to aid in the adoption of new and creative ways of leading business and achieving economic stability Freytag and Thurik (2010) The third approach to become economically powerful is to build entrepreneurial capital by creating competition among different businesses. Entrepreneurship has direct linked with economic and social development of the country. As a result, entrepreneurship is becoming increasingly popular. The Higher Education Commission has recognized its importance in raising public knowledge about entrepreneurship and fostering professionalism among individuals in order to improve their standard of life. As a result, the government's involvement in enabling entrepreneurship is critical, but unfortunately, in the past, it has played a more negative than positive role. Because of the government's policies and regulations, Pakistani entrepreneurship has suffered greatly. As a result, entrepreneurship in Pakistan never flourished as it should have, Therefore the purpose of this study was to explore the entrepreneurship education course offered by the three public universities in the Jamshoro higher education city.

2. Literature Review

Entrepreneurial education is seen as a driving force that promotes economic growth and immunizes individuals with business skills in preparation for the formation and valuation of a company venture Kirkley (2016). Furthermore, it is regarded as a program that concentrates on the start-up and development of businesses within the state-defined norms and regulations Noor, Md. Isa, and Mohd Nor (2020) Entrepreneurial education is significant because it provides students with the skills and information required to start a innovative business venture, as well as inspiring individuals to start their own business by increasing their self-confidence Khan (2008) Haque, 2007; Kuratko (2005); Nabi, G. and Holden (2008), Asghar (2019) The Worldwide universities, particularly in emerging countries, are working hard to promote entrepreneurial education by establishing and constructing innovative curriculum that include the most recent developments in the area (Krueger, B. A. & Lindahl (2001); Kuratko (2005); Tanveer, Muhammad and Karim, Asif Mahbub Dr. (2019)

According to the estimates, significant progress has been made in this sector in the United States and Europe. Entrepreneurial education has provided 277 endowed posts, over 2,200 courses at over 1,600 schools, 44 academic publications, and the conventional of management journals devoting more to the area of entrepreneurship, much as it has done in the United States Asghar (2019). It's perfect evidence that education of entrepreneurship can be taught, and it disproves the notion that entrepreneurs are born rather than produced Nabi, G. and Holden (2008); Anjum, T., Ramzani, S. R., & Nazar (2020)). According to Drucker (1985), a famous management theorist of the twentieth century, "the entrepreneurial mystique" is "not mystical, not God-given, and has no genetic relation." A discipline may be learned by anyone. Higher Education Institutions play a key role in fostering an entrepreneurial culture and emphasizing entrepreneurial education by helping to inspire students from many disciplines to pursue entrepreneurship Shah and Soomro (2017). Universities educate students the skills and strategies for starting a firm, as well as assisting in the development of legislation and infrastructure supporting entrepreneurship. Higher Education Institutions should emphasize this technique, emphasizing that a graduate is more than just a job seeker, but also a job creator Schulte (2004); Tanveer, Muhammad and Karim, Asif Mahbub Dr. (2019)

Many academics argue that entrepreneurship courses not only educate students with fundamental entrepreneurial information and skills, but also help them develop a favourable attitude toward entrepreneurship. Entrepreneurs must have the essential abilities to cope with business difficulties in order to prosper. Improved abilities can boost students' confidence in business and enhance their chances of success. According Marcati, A., This work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License.

Guido, G., Peluso, A.M. (2008), entrepreneurship education allows students to examine the variables that contribute to business failure and prevent making the similar mistakes. Entrepreneurship education has the ability to change how people think about business failure and entrepreneurship. According to Donckels (1991); Johannisson (1991); Kirkley (2017), entrepreneurial education may legitimize entrepreneurship as a feasible career choice and create entrepreneurial culture among students. Based on an empirical research of 17 countries students, Kuttim, M., Kallaste, M., Venesaar, U. and Kiis (2014) demonstrated that contributors in entrepreneurship education had higher entrepreneurial ambitions. In addition Souitaris, V., Zerbini, S. and Al-Laham (2007) discovered that entrepreneurship programs increased total entrepreneurial intention due to psychological inspiration, based on an empirical study of science and engineering students. Noel (2001) also discovered that graduate students who majored in entrepreneurship had higher aspirations to establish their own firms, claiming that education might influence self-efficacy (Gist, M.E. and Mitchell 1992).

3. Research Gap

In today's world, many scholars have been given a lot of attention to entrepreneurship (Ratten and Jones (2021)). In Pakistan, the status of entrepreneurship education is still not particularly encouraging. While for more than two decades HEIs have been offering entrepreneurship education, but still people are unfamiliar with this discipline of education and it is considered an alien subject in Pakistan. University graduates are less ready to become entrepreneurs. Entrepreneurship education has been failed to influence students to involve in entrepreneurship activities. This was also confirmed by Anon (2005), whose research has shown that graduates who have become entrepreneurs have done so through unintended career pathways, entering occupational while waiting to find employment in order to gain experience. Around a decade ago, Pakistan's Higher Education Commission (HEC) recognized the importance of incorporating entrepreneurship education into higher education in order to keep up with changing international movements and trends. It is still limited to one or two courses at the undergraduate and post-graduate levels in Pakistan. However, given the current status of entrepreneurship, it is clear that making it functional and efficient for the country's economic and social growth would be a difficult challenge. The focus of this study was to explore the status of entrepreneurship education course offered by the three public universities in the Jamshoro higher education city.

3.1. Research Question

1. What is the status of entrepreneurship education of the three public universities in the Jamshoro higher education city?

3.2. Objective Of The Study

1. To explore the entrepreneurship education course offered by the three public universities in the Jamshoro Higher education city.

4. Methodology

The following research consists of Quantitative approach. The data were collected from secondary data taken from the existing literature, official websites, prospectus, departmental reports and universities' policy documents of the public universities in the Jamshoro higher education city in order to explore the entrepreneurship education courses that offered to the students of the Jamshoro higher education city. The secondary data is the assessment of the data that has been collected. This data is inexpensive and conveniently available, and it offers a comprehensive contextual on a given study area Andersen, J. P., Prause, J., & Silver (2011). As a result, secondary data can be used for a variety of purposes, such as solving a research problem or providing a stronger explanation for an ambiguous topic Boslaugh (2007). However, the secondary data gathering has several advantages over the primary data. Secondary data involve access to current information that is less time demanding than primary data, or it might be seen as legitimate and reliable data since it was obtained by an experienced researcher, official websites, prospectuses and departmental reports.

The universities under the studied

- 1) Mehran University of Engineering & Technology, Jamshoro (MUET)
- 2) University of Sindh (UOS)
- 3) Liaquat University of Medical and Health sciences (LUMHS)

5. Results And Discussion

To explore the entrepreneurial education courses in the Jamshoro public universities, the results and discussion of study is provided in tabular form and presented descriptively.

According to the results of the Jamshoro universities, only Mehran University of Engineering and Technology (MUET) has offered an entrepreneurship course to more departments, as shown in Table 1. MUET has a total of 24 departments, 16 departments, of which offer an entrepreneurship course to the students.

Table 1.1 lists the names of all departments of Mehran University of Engineering and Technology that offered entrepreneurship courses. The question arises here, why all departments do not provide an entrepreneurship course to their students?

Table 1. Mehran University of Engineering & Technology

Mehran University of Engineering & Technology (MUET)								
Establishment year	No of faculty	No of Dept.	Is Entrepreneurship offered as specialized subject?	Is Entrepreneurship offered as a core Course?	ORIC Dept.	No of incubators	No of Start-up	No of Patents
July 1976	4	24	No	Yes Entrepreneurship course offered in 16 departments of bachelors	Yes Available	2 Namely; 1 Research, innovation & commercialization 2: Science & Technology park	Five Start-up companies registered	14 Patents registered

Table 2. Mehran University of Engineering and Technology (MUET)

SR#	MUET DEPARTMENTS
1	Department of Civil Engineering
2	Department of Environmental Engineering
3	Department of Computer System
4	Department of Electronic Engineering
5	Department of Software Engineering
6	Department of Telecommunication
7	Department of Chemical Engineering
8	Department of Industrial Engineering
9	Department of Mechatronic Engineering
10	Department of Metallurgy & Material
11	Department of Textile
12	Bachelor of Business Administration
13	Bachelor Studies in English
14	Bachelor Science in Garments manufacturing
15	Bachelor of Science in Computer Science
16	Bachelor Studies in Environmental Science

Source:

Mehran University of Engineering & Technology, (2021).prospectus. URL:
[http://www.admissions.mueta.edu.pk/prospectus/Prospectus%202021-22%20\(Revised\).pdf](http://www.admissions.mueta.edu.pk/prospectus/Prospectus%202021-22%20(Revised).pdf)
<https://www.mueta.edu.pk/>

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Table 2 Table University of Sindh (UOS)

University of Sindh (UOS)								
Establishment year	No of faculty	No of Dept.	Is Entrepreneurship offered as specialized subject?	Is Entrepreneurship offered as a core Course?	ORIC Dept.	No of incubators	No of Start-up	No of Patents
1947	9	60	No	Yes Entrepreneurship course offered in 8 departments of bachelors	Yes Available	The First ever technology incubation center (TIC)	No	N0

Table 3 Table University of Sindh (UOS)

1	BS/MS Commerce
2	Banking Finance
3	BS/MS Business Administration
4	Department of Electronic Engineering
5	BS Sociology
6	MS of Art Sociology
7	BS Public administration
8	M.A Women Development Studies

The University of Sindh (UOS) has a total of 60 departments, but Table 2 shown only 8 departments they offer an entrepreneurship course. When comparing Mehran University of Engineering & Technology to Sindh University, we can see that Mehran University of Engineering and Technology is more conscious about entrepreneurship. However, Sindh university just 8 departments offered entrepreneurship courses. The results shown Mehran University of engineering and technology are more entrepreneurial in their approach.

Source:

Sindh University (2021) .Prospectus. URL:

<https://usindh.edu.pk/>

https://admission.usindh.edu.pk/eportal_resource/files/Prospectus_2021.pdf

Table 3. Liaquat University of Medical and Health Science

Liaquat University of Medical and Health Science (LUMHS)								
Establishment year	No of faculty	No of Dept.	Is Entrepreneurship offered as specialized subject?	Is Entrepreneurship offered as a core Course?	ORIC Dept.	No of incubators	No of Start-up	No of Patents
1881	5	16	No	Not offered to any Depts.	Yes Available	N0	No	N0

Table 3 shows that the Liaquat University of medicine and health has 10 departments, none of them offered an entrepreneurship course. There is a lack of awareness regarding entrepreneurship

While most students recognize the importance of education, they may limit their studies to the more conventional topics of History, science, English, mathematics, foreign language, and the arts. Many students, on the other hand, understand that entrepreneurship courses supplement their education by teaching collaboration skills, communication, time management, and negotiation, among other things. Indeed, entrepreneurship is more than a subject; it is a mindset that pushes people to solve problems swiftly and creatively in order to create value. Entrepreneurship education is equally important for all departments for preparing the students for their future.

Prior studies Wardana et al. (2020) discovered that entrepreneurial education offers basic entrepreneurship knowledge that prepares students to be competent and experts in the new business launch process. The results offer new understandings into Pakistani entrepreneurial education/ course, assisting business students in gaining

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information and experience in starting and managing a new firm. Entrepreneurial education teaches students how to recognize and take advantage of market opportunities. It encourages students to get more information, abilities, and inspiration in order to boost their entrepreneurial mindset (Yuan et al., 2021).

Source:

LUMHS (2021).prospectus.URL:

<https://lumhs.edu.pk/admissions/technologies/propectus20-21.pdf>

<https://www.lumhs.edu.pk/home/>

6. Conclusion

Pakistan, being a developing country, faces certain issues like unemployment, low economic growth and poverty. Entrepreneurship is the one of the solution to reduce these problems. A small business which is formed by persons with an entrepreneurial mindset, which motivates them to start firms on a high level, produce wealth and the most the jobs. People who are exposed to entrepreneurship are more likely to rapid their self because they have more opportunities to implement higher self-value, creative freedoms and have adequate control over their life. As a result, higher educational institutions in Pakistan must devote greater emphasis to entrepreneurship education to provide opportunities for early people to establish their own businesses, which would reduce unemployment, create jobs for others and enhance the growth of our country.

Entrepreneurship has become an important part of the today's educational system. Entrepreneurial education must be introduced as a compulsory subject and implemented within the present educational system. This course teaches not only the business area, but also other fields that should be included in the educational system as a compulsory subject. All over the world universities are becoming gradually more entrepreneurial, not only offering educational programs, but also seeing themselves as main players within the Social and economic development and innovation ecosystem Etzkowitz (2003).In Pakistan, entrepreneurial education is still an unfamiliar concept. Entrepreneurship education in most universities and colleges is still limited to one or two disciplines offered in undergraduate and postgraduate degrees. The results of this study indicated the public universities of the Jamshoro higher education city, just one core course on entrepreneurship was offered to some departments. Furthermore entrepreneurship programs were extremely rare. After review and reading existing literature, articles, official reports of universities the results show in many other countries like the USA, Europe all are starting to transform their universities into entrepreneurial university. Looking forwards, both the public and private sectors must create an atmosphere that encourages overseas entrepreneurs to come to Pakistan and start a firm. Pakistan, like model nations such as the United States, the United Kingdom, and China, must develop a road plan for entrepreneurial activity, since this is one of the methods to reduce poverty and unemployment.

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Evaluation of Clean Water Distribution Development in Bee Timor-Leste, E.P Post Administrative Dom Aleixo Dili Municipality

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Abstract

Post Administrative Dom Aleixo is a part of Dili City with an area of 33.12 km², the population in 2015 was 130,095 people. The purpose of this study was to determine the discharge capacity of the springs which is still sufficient to distribute water for the next 10 years. The method used is geometric and Epanet 2.2. The simulation results of Epanet 2.2 for the development of a clean water distribution network system are known to have 46 nodes that have residual pressure below the BTL, E.P standard. It takes repairs for 30% of the pipes because the pipe diameters are no longer able to drain water according to the standard hydraulic criteria. Repair efforts are to replace the pipe diameter to reduce water loss by 20% and can meet technical parameters, namely speed, pressure loss so as to be able to flow clean water. From the results of the analysis, it is found that the need for clean water customers in 2020 is 47.63 lit/sec with the largest total customer demand in 2030 is 91.23 lit/sec. This is because the potential of water sources can only serve the needs of the population until 2024.

Keyword

Water Distribution System, Epanet 2.2, Evaluation and Strategic Development Plan 2011-2030.

1. Introduction

The clean water distribution system in East Timor has started to develop since the Portuguese colonial government in 1515-1974. After Indonesia ruled for 24 years in East Timor clean water infrastructure began to develop well until East Timor became independent. In an effort to utilize clean water sources, the government established a public company named BEE TIMOR-LESTE, E.P (BTL, E.P) based on Decree Law No. 41/2020 for controlling conditions on the ground and developing a clean water distribution network system in East Timor.

The primary objective is to promote greater efficiency and sustainability for the implementation of the Government's strategy in providing water and sanitation services to the public especially in the Post Administrative Dom Aleixo Dili Municipality in accordance with the Strategic Development Plan 2011-2030 and upcoming SDG 6 (Sustainable Development Goal).

Recently the community Post Administrative Dom Aleixo has reached quite a large number with the increase in population every year, the necessities of life that must to be met are also getting bigger, one of the main necessities of life the need for clean water because water is one of the needs of creatures in human life that has a very vital function that must be fulfilled when necessary, because daily human activities are never separated from water. Starting from bathing, washing clothes, cooking or drinking, washing kitchen utensils, washing vehicles, watering plants and which one of the elements human body also consists of clean water. One of the main obstacles faced is the lack of availability of clean water, even the unavailability of clean water services in rural areas and clean water sources that have not been used optimally.

Post Administrative Dom Aleixo is one Post Administrative served by BTL, E.P Dili Municipality with an area of 33.12 km², total population in 2015 as many 130,095 inhabitants, divided into 7 Sucos that is Suco Bairro Pite, Bebonuk, Comoro, Fatuhada, Kampung Alor, Madohi, Manleuana.

2. Methodology

After knowing the research location, then carried out data collection that needs to be done in conducting the study. Data required include: evaluated population data, topographical data and provisioning facilities existing clean water, BTL, E.P Post Administrative Dom Aleixo service data in Dili Municipality on end of 2030. To project the population, we use 3 methods, namely Geometric, Exponential and Arithmetic, after our trial, we choose the most appropriate Geometric method using a population trial for the next 10 years.

In this method used Epanet 2.2 program. The data needed in Epanet 2.2 is a map of the network system, the elevation of each junction, the water discharge, pipe and the pipe roughness value.

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Table 1. Population Data

No.	Suco		Total Population	
			2010	2015
01.	Bairo-Píte		27875	34993
02.	Comoro		65404	76681
03.	Fatuhada		7178	14890
04.	Kampung Alor		4697	3531
05.	Madohi		New Suco	New Suco
06.	Bebonuk	New Suco	New Suco	
07.	Manleuana	New Suco	New Suco	
	Total	105154	130095	

Source : General Directorate of Statistics Timor-Leste

2.1 Site Location

Location analysis was carried out by direct observation to see the existing conditions in the field and data from BTL, E.P Post Administrative Dom Aleixo branch with area is 33.12 km². It is divided into 7 (seven) Suco namely Bairo-Píte Suco, Bebonuk Suco, Comoro Suco, Fatuhada Suco, Kampung Alor Suco, Madohi Suco and Manleuana Suco.

In this study, there were only 4 (four) suco such as the Bairo-Píte Suco, Comoro Suco, Fatuhada Suco and Kampung Alor Suco according to the data we got from the agency, namely the Directorate General of Statistics of Timor-Leste and the Post Administration Dom Aleixo. The following is the area and map of the Dom Aleixo Administrative Post as shown in diagram 1 and figure 1.

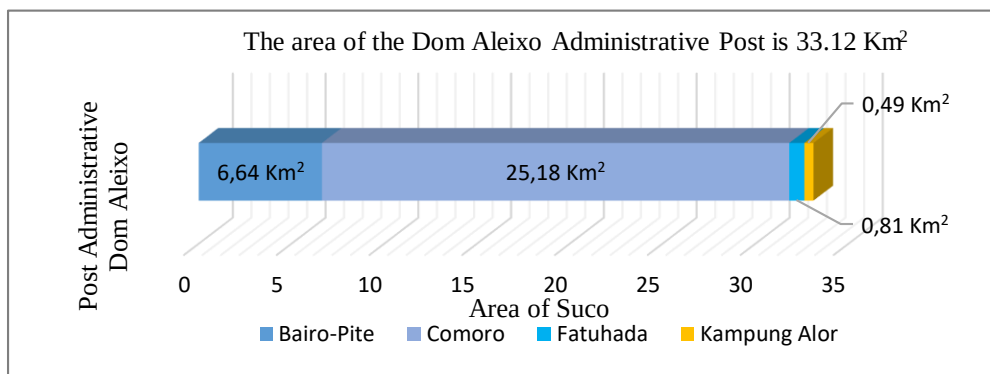


Diagram 1. Area of Post Administrative Dom Aleixo

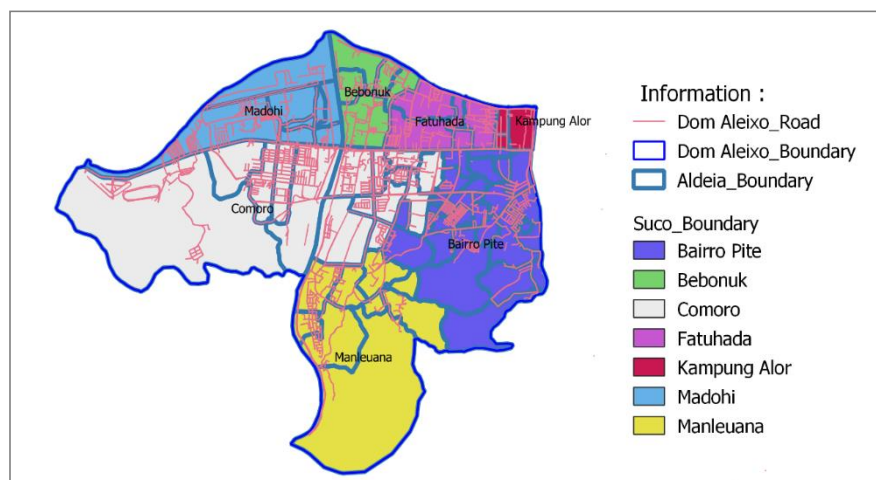


Figure 1. Map of Post Administrative Dom Aleixo

2.2 Analysis Stage

The stages of case studies in this research are made systematically and regularly based on the steps and concepts of research completion as follows : (Rashid et al., 2019)

1. Start
2. Problem identification
3. Initial orientation
4. Literature study
5. Survey data collection
6. Data analysis
7. Conclusions and suggestions
8. Finish

For more details about the stages of case studies in this research and concepts of research completion as follows:

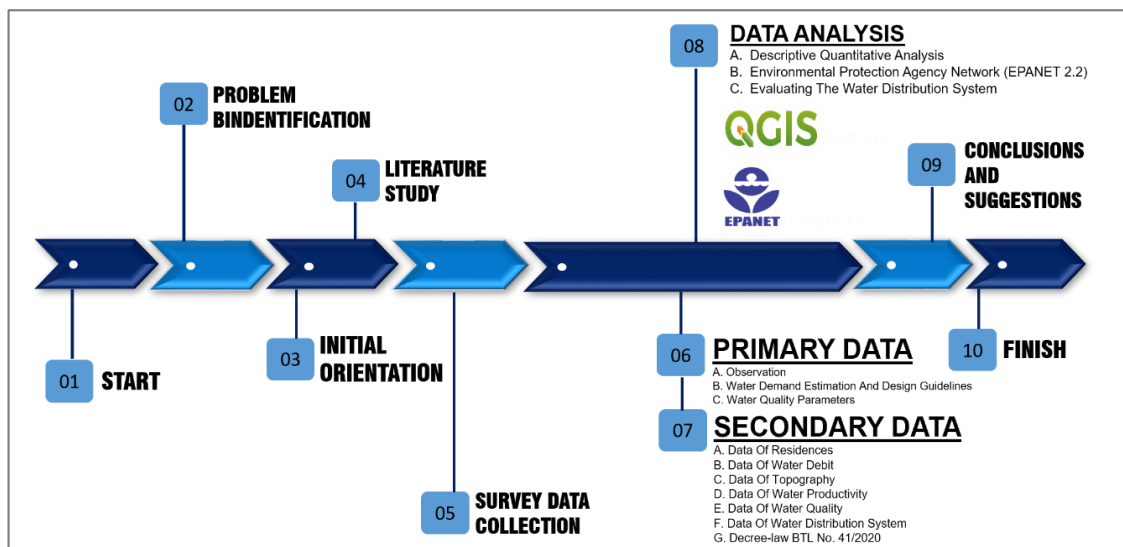


Figure 2. Research Flowchart

3. Results and Discussion

3.1 Projection of Population Growth

Population growth per Suco in Post Administrative Dom Aleixo according to the results of data analysis by census population 2010 and 2015 how to calculate the population growth rate to determine the rate of increase future users of clean water services. For the results of analysis 2021 shown in table 2.

No.	Suco	Total Population		Area (km ²)	r (growth rate)	r (growth rate) in %
		2010	2015			
01.	Bairro-Píte	27875	34993	6.64 km ²	0,047	5 %
02.	Comoro	65404	76681	25.18 km ²	0,032	3 %
03.	Fatuhada	7178	14890	0.81 km ²	0,157	16 %
04.	Kampung Alor	4697	3531	0.49 km ²	-0,055	-6 %
	Total	105154	130095	33.12 km ²	0,181	18 %

Table 2. Population Growth per Suco

3.2 Population Projection

In planning the need for clean water for the population in the next 10 years, population data for the next 10 years in needed. The following uses the geometric method to project the population in 2020 to 2030 in the future.

Projection of the population using this geometric method every years, starting from 2020-2030 according of census population 2015. For the results of analysis 2021 shown in table 3.

Table 3. Population Projection Post Administrative Dom Aleixo

Year	Population Projection Using Geometric Method			
	Suco			
	Bairo-Píte	Comoro	Fatuhada	Kampung Alor
2020	43929	89902	30888	2654
2021	45973	92809	35741	2507
2022	48112	95809	41356	2368
2023	50351	98906	47854	2237
2024	52694	102103	55373	2113
2025	55146	105403	64073	1996
2026	57712	108811	74140	1885
2027	60398	112328	85789	1780
2028	63208	115959	99269	1682
2029	66150	119708	114866	1588
2030	69228	123577	132913	1500

3.3 Projected Clean Water Demand

The calculation of domestic water is based on the projected population of the year planning, it can be categorized as metropolitan city water needs net 120 liters/person/day. The average number of people per house or per connection is 6 (six) people.

The customers served by BTL, E.P at the Post Administrative Dom Aleixo are currently 67% of the total 11,917 households usage water 8580240 liter per day, meanwhile 5,809 households have not been served with a percentage of 33% according to 2015 population census data. For more details about total household's per suco usage water every day as follows:

Table 4. Water Demand Data Post Administrative Dom Aleixo

No.	Suco	Amount Customer (households)	Usage Water (l/day)	Usage Water (l/sec)
01.	Bairo-Píte	4115	2962800	34,319166667
02.	Comoro	4939	3556080	41,158333333
03.	Fatuhada	1229	884880	10,2416667
04.	Kampung Alor	1634	1176480	13,616666667
Total		11917	8580240	99,308333333

3.4 Calculation of Projected Water Needs

The following is the calculation of clean water needs in Suco Bairo-Píte, Suco Comoro, Suco Fatuhada and Suco Kampung Alor according to service data from BTL, EP in 2020 and also uses the results of the number of families or households in the census 2015 to target water services clean in the next 10 years.

Table 5. Projection of Clean Water in the Next 10 Years

Year	% of Population Service (%)	Water Needs (lit/per/d ay)	Domest ic Needs (lit/day)	Non Domesti c Needs (lit/day)	Social Needs (lit/day)	Total Requirem ent (lit/day)	Total Maximu m Daily Needs (lit/day)	Total Demand at Peak Hours (lit/day)
2020	67	2008478 1	658781	1646952 1	16469 521	33597822	4838086 4	70555427
2021	70	2124351 8	696787	1741968 4	17419 684	35536156	5117206 5	74625928
2022	74	2251742 3	738571	1846428 7	18464 287	37667146	5424069 0	79101006
2023	77	2392171 6	784632	1961580 7	19615 807	40016247	5762339 6	84034119
2024	80	2547391 3	835544	2088860 9	20888 609	42612762	6136237 7	89486799
2025	84	2719418 4	891969	2229923 1	22299 231	45490431	6550622 1	95529905

2026	87	2910576	954669	2386672	23866	48688127	7011090	10224506
		7		9	729		4	8
2027	90	3123544	102452	2561306	25613	52250650	7524093	10972636
		4	3	4	064		6	6
2028	93	3361409	110254	2756355	27563	56229649	8097069	11808226
		0	2	3	553		4	3
2029	97	3627731	118989	2974739	29747	60684690	8738595	12743784
		4	6	7	397		4	9
2030	100	3926619	128793	3219828	32198	65684492	9458566	13793743
		6	1	0	280		8	3

3.5 Water Recourse and Water Usage Fluctuation

Water resources provided for the Dom Aleixo administrative post are divided into two, namely water from rivers (water above ground) and water from pumps (water below ground). The river originates from two rivers, namely the Tohumeta River with an area of 47.2 km², and the Maloa River with an area of 5.74 km². The source of water from the pump or water below the ground at the Dom Aleixo administrative post consists of 13 (thirteen) pumping stations namely, Bairro-Píte A, Bairro-Píte B, Markoni, Bebonuk, Comoro A, Comoro B, Comoro B1, Comoro C, Comoro D, Comoro E, Inap Office, Brimob and Manleuana.

According to the results of the calculation of water needs, the calculation of fluctuations in water demand for the Dom Aleixo administrative post service area in 2030 is as follows:

Table 6. Projection of Fluctuations in Water Demand

Year	Total population (person)	Demand (person)	Water Needs (liter/person/day)	Water Production (liter/day)	Residual Water And Water Loss (liter)
2020	167373	27896	20084781	24747748	4662967
2021	177029	29505	21243518	24747748	3504230
2022	187645	31274	22517423	24747748	2230325
2023	199348	33225	23921716	24747748	826032
2024	212283	35380	25473913	24747748	-726165
2025	226618	37770	27194184	24747748	-2446436
2026	242548	40425	29105767	24747748	-4358019
2027	260295	43383	31235444	24747748	-6487696
2028	280117	46686	33614090	24747748	-8866342
2029	302311	50385	36277314	24747748	-11529566
2030	327218	54536	39266196	24747748	-14518448

3.6 Clean Water Network Hydraulic Analysis with Epanet 2.2 Program

The clean water distribution network system at the Dom Aleixo administrative post uses a gravity system. This network system is in accordance with topographic conditions that have a high enough elevation difference. This clean water network system uses PVC type pipes with Hazen-Williams C= 140. Meanwhile, the pipe diameters used vary and the basic planning is carried out as follows:

1. Pipe diameter data and pipe types come from distribution network data via BTL, E.P Dom Aleixo administrative post and also field surveys to obtain maximum power.
2. Elevation data is obtained using the Google Earth program and tracking results using the Global Positioning System (GPS) in the field after that, digitizing the map data using the Quantum GIS (Geographic Information System) program, QGIS.
3. The peak hour factor (Phour) is 1.75 in accordance with the standard peak hour for the Metropolitan City category with peak hours in the morning between 06:00 OTL – 07:00 OTL and in the afternoon at 18:00 OTL – 19:00 OTL.

For more detailed evaluation results, we can see in the Table 7 as follows:

Table 7. Epanet Evaluation Results from the Residual Head

No.	Parameters	Amount of Junction	Percentage
01.	Residual Head < 10 Meter	14	17 %
02.	Residual Head > 10 Meter	73	83 %
	Total	87	100 %

Table 8. Epanet Evaluation Results in terms of Flow Speed

No.	Parameters	Number of Pipes	Percentage
01.	0,3 m/sec – 2m/sec	62	71 %
02.	Head loss < 10 m/km	25	29 %
	Total	87	100 %

Table 9. Epanet Evaluation Results Judging from Remaining Press / Head loss

No.	Parameters	Number of Pipes	Percentage
01.	Head loss > 10 m/km	18	20 %
02.	Residual Head > 10 Meter	69	80 %
	Total	87	100 %

4. Conclusion

Based on the results of data analysis in this research study, the following conclusions can be drawn:

- The results of the projected population for the Dom Aleixo Administrative Post service area in 2030 based on the geometric method, namely 327,218 people in the sucos of Bairro-Píte, Comoro, Fatuhada and Kampung Alor.
- The results of the calculation of water needs in 2030 to come are:
 - Suco Bairo-Píte average daily demand is 16675797 liter/day, maximum demand is 23160828704 liter/sec and total demand during peak hours is 33776208333 liter/sec with the percentage of service in 2030 is 22%.
 - Suco Comoro average daily demand is 29767657 liter/day, maximum demand is 41343967593 liter/sec and total demand during peak hours is 60293287037 liter/sec with the percentage of service in 2030 is 25%.
 - Suco Fatuhada the average daily demand is 32016580 liter/day, the maximum demand is 44467472222 liter/sec and the total demand during peak hours is 64848396991 liter/sec with the percentage of service in 2030 is 28%.
 - Suco Kampung Alor the average daily requirement is 361356 liters/day, the maximum demand is 501884259 liters/sec and the total demand at peak hours is 731914352 liters/sec with the percentage of service in 2030 is 25%.
- From the simulation results of the Epanet 2.2 program for the development of a clean water distribution network system at the Dom Aleixo administrative post, it is known that there are 46 nodes that have residual pressure below the BTL, EP standard in 2020. Repairs are needed for 30% of pipes due to pipe diameters that are no longer able to drain. Water according to hydraulic criteria standards. Improvement efforts that can be made are by replacing the pipe diameter to reduce water loss by 20% and can meet technical parameters, namely speed, pressure loss and residual pressure so that clean water can flow to the service area according to hydraulic criteria.

5. Development Suggestions

From the research that the author conducted and the problems found, the researchers provide suggestions that are expected to be able to build or be used as input or consideration by the government, especially the clean water public riots in Timor-Leste related to maximizing the management of clean water distribution networks in Timor-Leste, especially in Timor-Leste. Dom Aleixo Administrative Posts are as follows:

- In the future development of a clean water distribution network system at the Dom Aleixo administrative post, calculations can be made to increase the storage capacity so that it can meet future water needs.
- New installations to replace old pipes at the Dom Aleixo Administrative Post because through observations from researchers, pipes in the area still use the old pipes and replace the installed water treatment facilities because there are damaged facilities.
- For the 15 to 20 year development plan should look for new water sources. This is because the potential water source of the Dom Aleixo Administrative Post can only serve the needs of the population until 2024.
- Controlling the clean water treatment system with proper functioning and testing every day and every month.
- For students who want to plan a clean water distribution network system, they can use the EPANET program because it has benefits in its use. And need to learn better in the use of the EPANET program.

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Administrative Dom Aleixo Dili Municipality". As a Human I am aware of limitations, shortcomings and mistakes. However, I have tried my best to do my best. I take this opportunity to express my deepest gratitude to:

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Biography

Zeferino Soares Lopes is the name of the author of this Journal. The author was born in Maubisse, East Timor on February 25, 1996, and the eldest of five children from Mr. José Casimiro Lopes and Mrs. Madalena da Costa. In 2008 the author graduated from primary school No. 1 Maubisse Villa, in 2011 graduated from Junior High Scholl SMPK Sagrado Coração de Jesus Aituto, Ainaro in 2014 graduated from Senior High School at SMAK São José Operário Balide Dili, Timor-Leste. In 2016 the author was accepted as a student with the Civil Engineering study program at Narotama University Surabaya, Indonesia though an International Scholarship with a period of four years, graduating in the 2020. After graduated author get more opportunity from Diponegoro Master Scholarship to continue study program in master's degree at Diponegoro University Semarang, Indonesia. In 2022 Praise God will lead the author to get a master's degree in Environmtal Engineering. The author also active in the world of movements and national organizations, International organizations like Toastmasters Club, Rotary Club and etc. Currently the author works at CRIG-COVEC International Company as an Environmental Officer until now. Author Motto "Success Comes From Effort".