Original Article
ISSN (Online): 2454-1907

International Journal of Engineering Technologies and Management Research
January 2025 12(1), 28–37

ANALYSIS OF HOUSING CONSTRUCTION TIME IN THE PURBALINGGA REGENCY AREA BY USING THE LINEAR SCHEDULING METHOD

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Received 25 December 2024
Accepted 05 January 2025
Published 31 January 2025

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DOI
10.29121/ijetmr.v12.i1.2025.1529

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ABSTRACT

The realization of a construction project is closely connected to its cost and time. Work time planning illustrates the time of every work item from start to finish so that the total project completion time can be known. This study is a further analysis of the effects of using the linear scheduling method on total project time in a housing construction project to give a clear overview of potential differences. This study aimed to find the time needed to complete a housing project in Pubalingga Regency.
Using LSM as a scheduling tool provides convenience in planning, executing, and controlling every work item, making it easier for the stakeholders to monitor the progress.
This study concluded that using the Linear Scheduling Method (LSM), the time needed to complete 16 (sixteen) houses in Payodha Residence is 112 days

Keywords: Time Analysis, Housing Project, Linear Scheduling Method (LSM)

1. INTRODUCTION

The realization of a construction project is closely connected to its cost and time. The capability to manage cost and time becomes essential because it is related to funds availability and completion time needed in project execution. With a good capability, construction projects will be completed with effective and efficient cost and time.

Related to time schedules, some methods that can be implemented in construction projects are the Barchart Method, Critical Part Method (CPM), Linear Scheduling Method (LSM), and Line of Balance (LoB). Using a method makes work time planning easier for construction project stakeholders. Work time planning will illustrate the time of every work item from start to finish so that total project completion time can be obtained.

Sometimes, project execution does not follow the completion time because of the stakeholders' lack of work competency. The project time nonconformity gives disadvantages to contractors and project owners. An inaccurate time plan can cause longer project completion and disadvantage the stakeholders.

According to Tavener (2023), almost 90% of big-scale construction project completion is late. The ability to make construction projects run by the plan is a challenge that must be faced by every construction company. To be able to do this, a proper method is needed so the company can finish the project on time. Based on that, a study of scheduling methods is required to obtain a comprehensive time description. The study was conducted in a housing construction project in the Purbalingga Regency area using Linear Scheduling Method (LSM).

Linear Scheduling Method (LSM) is one of the methods to make a time plan for each work item until all construction project stages are completed. Using LSM is convenient because there is no stacked or overlapped work at one point. Therefore, it is easier to manage the work and more efficient in using workers to execute the project.

Based on the above background, this study formulated the time needed to finish a housing project in the Purbalingga Regency area using the linear scheduling method (LSM).

To maintain the focus of the study, some boundaries are set they are;

1) The study was conducted in the Payodha Residence housing project located in Purbalingga Regency.
2) Only reviewed the schedule of a housing project that related to time.
3) The review is based on a schedule used by the developer and does not refer to actual housing construction that is being executed.

The results of several studies that had been conducted that related to the review of using the Linear Scheduling Method (LSM) are made as literature in this study, some of the studies are as follows:

1) Verolio & Pamadi (2023), Through their study with the title of Schedule Analysis of Linear Scheduling Method or Line of Balance (LSM/LoB) of Devely Residence Housing in Batam, concluded that by using the LSM method, 220 units of Devely Residence can be completed in 349 days, whereas the execution needs 365 days, so there are 16 days difference of project completion.
2) Utami A and Nugraheni F (2023), conclusions of their study titled Scheduling Time Analysis with Linear Scheduling Method (LSM) in Housing Project is that by using LSM the time duration is more effective because with LSM the time is 190 days while the existing schedule has 730 days duration, so there are 540 days differences.
3) Tania (2022), conducted a study titled The Comparison of Project Schedule and Cost using Linear Scheduling Method (LSM), the result is

that the project duration is 6,25% faster or 3 days compared to scheduling using bar chart and there are changes in cost in every week.

Based on the above study, it can be concluded that there are differences between scheduling time using LSM with its execution time. The study that will be conducted will analyze further the effect of using LSM on project time as a whole in a housing project to get a better description related to the differences that might occur.

2. MATERIAL AND METHOD

According to Ervianto (2002), a construction project is a series of activities executed once, generally short term, have unique traits, and require resources and organization to be executed.

There are two types of building groups in construction projects. They are construction buildings such as houses, factories, offices, etc, and civil infrastructures such as bridges, ducts, highways, etc.

The definition of a Housing

According to Constitution number 1 about housing and residential areas, housing is a group of houses as part of a settlement in the city and village completed with infrastructure to fulfill the need for proper habitable housing. Sadana (2014) stated that housing is a residential environment with infrastructure to support daily activities. The housing function is only for a residence and doesn't have a double function as a place to earn a living for the inhabitant.

Project Scheduling and its Purpose

Project scheduling, according to Husen, A. (2009), is allocating the available time to execute every work item to finish a project with optimum or the best result by considering the existing limitations. With project scheduling, the work process from start to finish can be seen. Project scheduling pointing the execution time of every work item that needs to be done so that it can give a depiction when allocating funds and other resources that are required by every work item until the project is completed.

The purposes of project scheduling, according to Faisol (2010), are as follows:

1) To understand the needed duration both for every work item and overall project.
2) Giving information on the time to start and finish every work item.
3) As a tool to provide and control the required resources.
4) As a tool to supervise, control, and evaluate the project
5) Giving information on the relationship among work items.

Linear Scheduling Method (LSM)

According to Aprika Business Solution (2023), the Linear Scheduling Method (LSM) is a tool used to develop a project schedule that has repetitive, sustainable, and linear activities. The project activities are in order, and each activity follows it.

The Linear Scheduling Method (LSM) has several important characteristics :

1) Point out the repetitive nature of a project.
2) Presenting the improvement of work.
3) Showing different sequences of activities
4) Have a higher level of detail
5) Require relatively shorter time compared to another scheduling method

If compared to the other scheduling methods, the Linear Scheduling Method (LSM) provides several advantages, such as:

1) This method can show and optimize the resources used in repetitive work that has many quantities in several zone points or locations.
2) Easily illustrate the productivity and the location of the worker group.
3) Minimize the waiting time between activities or tasks.
4) Helping optimize cost and time
5) Ease the control of the project execution to conform to the specified time.

Definition of Project Time

Project time is the required time to execute every work item until they are thoroughly completed. Project time execution must be controlled because if not carefully managed, it can delay the project completion from the assigned time.

3. RESULT AND DISCUSSION

The study is conducted at PT. INDOLOFIT works on Payodha Resident Housing in the Purbalingga Regency area. This housing consists of 16 (sixteen) units of houses

The data of work items that have been categorized in each group type for 1 (one) unit of house in Payodha Residents Housing can be seen in Table 1 as follows

Table 1

Table 1 Work Item and Duration

Number	Work Item	Duration	TOTAL (IDR)
1	Preparation	1	1.000.000
2	Earthwork	3	2.618.000
3	Foundation and Sloof Work	5	25.575.000
4	Column work	3	4.241.250
5	Ring Beam Work	5	6.150.000
6	Roof Structure and Covering Work	6	27.720.750
7	Bricklaying Work	5	8.820.000
8	Plaster and Wall Coating Work	6	10.400.000
9	Window and Door Frame Work	4	19.735.000
10	Ceiling Work	4	8.060.000
11	Ceramic Tile Work	5	8.200.000
12	Electrical Work	3	6.500.000
13	Mechanical and Sanitary Work	3	3.500.000
14	Painting Work	4	8.060.000
15	Cleaning Work	1	3.500.000
16	Waterway Work	3	4.000.000
17	Septictank Work	5	8.400.000
18	Canopy Work	1	520.000
	TOTAL	67	157.000.000

Note: The price of each work item is building price only (not including site price)

According to Table 1., it is seen that 18 (eighteen) work items must be executed for 1 unit of house in 67 days with IDR. 157.000.000,- (one hundred and fifty-seven million rupiah). Furthermore, based on the data from Table 1., a projection of scheduling using the Linear Scheduling Method (LSM) will be made.

Calculation of LSM Supporting Variables

Before Table 1. is made into an LSM graphic, variables used in creating LSM are calculated.

Therefore, some data and calculation formulas used are:

1) Deciding some data used as the base of LSM variable calculations, they are:
- Daily working time = 8 workhours
- Weekly working day = 6
- Weekly working time = 48 hours
- The number of houses that will be built = 16 units

2) A formula to calculate the amount of work time for every work type per unit with weekly target (M) = workers quantity x work duration x daily working hour

3) A formula to calculate total workers for weekly targets (N) = (M x unit of weekly target): work hour per week.

4) Determine the estimation of worker quantity for working group per work type (n): decided by field experience.

5) Calculate the number of needed workgroups (H), determined by field experience.

6) Calculate the number of workers needed in one group (A) = n x H

7) Calculate the actual average of the needed workgroup:

R = (A x weekly work hour): M

8) Calculation of execution time of work item in one unit

T = (M): (n x work hour per days)

9) Calculation of the needed time interval to start working on the last unit (T) = (unit target work – 1): R x working days

10) Determining Buffer Time (B). Determined based on field experience. Based on the above data and formulas, the variables used in LSM calculation are as follows:

Table 2

Table 2 Table of Supporting Variables of LSM calculation

Number	Work Item	Duration	Cost (IDR)	Number of Workers	M	N	n2	H	A	R	t	T3	B
1	Preparation	1	10,00,000	2	16	0.33	3	2	6	18	0.67	5	-
2	Earthwork	3	26,18,000	2	48	1	3	2	6	6	2.00	15	1
3	Foundation and Sloof Work	5	2,55,75,000	4	160	3.33	6	3	18	5	3.33	17	3
4	Column work	3	42,41,250	4	96	2	6	3	18	9	2.00	10	3
5	Ring Beam Work	5	61,50,000	4	160	3.33	6	2	12	4	3.33	25	3
6	Roof Structure and Covering Work	6	2,77,20,750	4	192	4	6	2	12	3	4.00	30	3
7	Bricklaying Work	5	88,20,000	3	120	2.5	5	3	15	6	3.00	15	1

8	Plaster and Wall Coating Work	6	1,04,00,000	3	144	3	5	3	15	5	3.60	18	2
9	Window and Door Frame Work	4	1,97,35,000	3	96	2	5	3	15	8	2.40	12	1
10	Ceiling Work	4	80,60,000	3	96	2	5	3	15	8	2.40	12	-
11	Ceramic Tile Work	5	82,00,000	3	120	2.5	5	3	15	6	3.000	15	2
12	Electrical Work	3	65,00,000	2	48	1	4	2	8	8	1.50	11	-
13	Mechanical and Sanitary Work	3	35,00,000	2	48	1	4	2	8	8	1.50	11	1
14	Painting Work	4	80,60,000	2	64	1.33	4	3	12	9	2.00	10	2
15	Cleaning Work	1	5,20,000	2	16	0.33	3	2	6	18	0.67	5	1
16	Waterway Work	1	35,00,000	2	16	0.33	4	2	8	24	0.50	4	1
17	Septictank Work	3	40,00,000	2	48	1	4	3	12	12	1.50	8	-
18	Canopy Work	5	84,00,000	2	80	1.67	4	2	8	5	2.50	19	1
		67	157.000.000										

Based on the data in Table 2, a calculation of the starting and finishing time of the 16 (Sixteen) unit houses was carried out. The results are:

Table 3

Table 3 Calculation of Starting and Finishing Time of Housing Project

Number	Work Item	Duration	Cost (IDR)	Number of Workers	Starting Day Unit 1	Starting Day Unit 16	Finishing Day
1	Preparation	1	10,00,000	5	0	5	6
2	Earthwork	3	26,18,000	15	1	16	19
3	Foundation and Sloof Work	5	2,55,75,000	17	4	21	26
4	Column work	3	42,41,250	10	9	19	22
5	Ring Beam Work	5	61,50,000	25	12	37	42
6	Roof Structure and Covering Work	6	2,77,20,750	30	17	47	53
7	Bricklaying Work	5	88,20,000	15	23	38	43
8	Plaster and Wall Coating Work	6	1,04,00,000	18	28	46	52
9	Window and Door Frame Work	4	1,97,35,000	12	34	46	50
10	Ceiling Work	4	80,60,000	12	38	50	54
11	Ceramic Tile Work	5	82,00,000	15	42	57	62
12	Electrical Work	3	65,00,000	11	47	58	61
13	Mechanical and Sanitary Work	3	35,00,000	11	50	61	64
14	Painting Work	4	80,60,000	10	53	63	67
15	Cleaning Work	1	5,20,000	5	57	62	63
16	Waterway Work	1	35,00,000	4	58	62	63
17	Septictank Work	3	40,00,000	8	59	67	70
18	Canopy Work	5	84,00,000	19	62	81	86
	Total	67	15,70,00,000				

Table 3 shows the starting time of each work item to finish all house units. The data in Table 3 makes it easier to create a project schedule.

Creating Linear Scheduling Method (LSM) Graphic

Using the acquired data from Table 3., the Linear Scheduling Method (LSM) schedule is created in a graphic form where the vertical axis shows the number of house units and the horizontal axis shows execution time (days). The graphic results shown in Figure 1 are as follows:

Figure 1

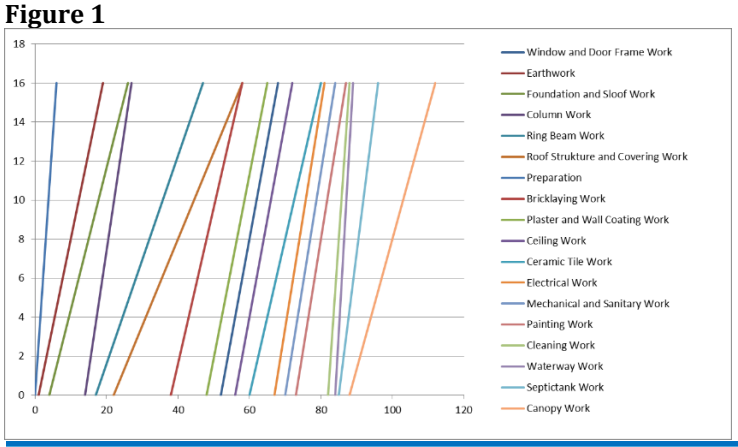

Figure 1 Graphic of Linear Scheduling Method (LSM) of Payodha Residence Housing Project

Figure 1 shows an LSM graphic that illustrates a series of activities that must executed so that all 16 (sixteen) units of houses in Payodha Residence are completed.

Analysis of Project Time based on LSM Graphic

Figure 1 is a graphic of the schedule of every work item that must be executed to complete every house unit. The graphics show several line intersections between work items, which are:

1) Foundation and Sloof Work intersect with Column work.
2) Roof structure and covering work intersects with bricklaying Work and Plaster and Wall Coating Work
3) Tile Work intersects with Electrical Work
4) Mechanical and Sanitary Work intersects with Electrical and Cleaning Work
5) Painting Work intersects with Electrical Work and Cleaning Work

The existence of 5 (five) intersects between works means that the schedule needs to be revised so that intersections between works can be erased and do not exist anymore.

In order to anticipate intersections between works, the intersects works are delayed. However, the delay will affect the following works.

The following Table 4 is a result of trial and error of work delay.

Table 4

Table 4 Calculation of Work Delay to Avoid Intersection

Number	Work Item	Duration	Cost (IDR)	Before Delay					After Delay		
				T	Starting Day Unit 1	Starting Day Unit 16	Finishing Day	Cumulative Delay	Starting Day Unit 1	Starting Day Unit 16	Finishing Day
1	Preparatiom	1	10,00,000	5	0	5	6	0	0	5	6
2	Earthwork	3	26,18,000	15	1	16	19	0	1	16	19
3	Foundation and Sloof Work	5	2,55,75,000	17	4	21	26	0	4	21	26
4	Column work	3	42,41,250	10	9	19	22	5	14	24	27
5	Ring Beam Work	5	61,50,000	25	12	37	42	5	17	42	47
6	Roof Structure and Covering Work	6	2,77,20,750	30	17	47	53	5	22	52	58
7	Bricklaying Work	5	88,20,000	15	23	38	43	15	38	53	58
8	Plaster and Wall Coating Work	6	1,04,00,000	18	28	46	52	15	43	61	67
9	Window and Door Frame Work	4	1,97,35,000	12	34	46	50	18	52	64	68
10	Ceiling Work	4	80,60,000	12	38	50	54	18	56	68	72
11	Ceramic Tile Work	5	82,00,000	15	42	57	62	18	60	75	80
12	Electrical Work	3	65,00,000	11	47	58	61	20	67	78	81
13	Mechanical and Sanitary Work	3	35,00,000	11	50	61	64	20	70	81	84
14	Painting Work	4	80,60,000	10	53	63	67	20	73	83	87
15	Waterway Work	1	5,20,000	5	57	62	63	25	82	87	88
16	Septictank Work	1	35,00,000	4	58	62	63	26	84	88	89
17	Canopy Work	3	40,00,000	8	59	67	70	26	85	93	96
18	Cleaning Work	5	84,00,000	19	62	81	86	26	88	107	112
	total	**67**	**15,70,00,000**								

Based on Table 4., the start of work begins to change in column work until canopy work. The changes happened because the column work was delayed for 5 days, bricklaying work for 10 days, window and door-frame work for 3 days, electrical work for 2 days, cleaning work for 5 days, and waterway work for 1 day. The delay of those work items makes the project completion time 26 days longer to 112 days.

The graphic that illustrates scheduling using the Linear Scheduling Method can be seen in Figure 2, as follows:

Figure 2

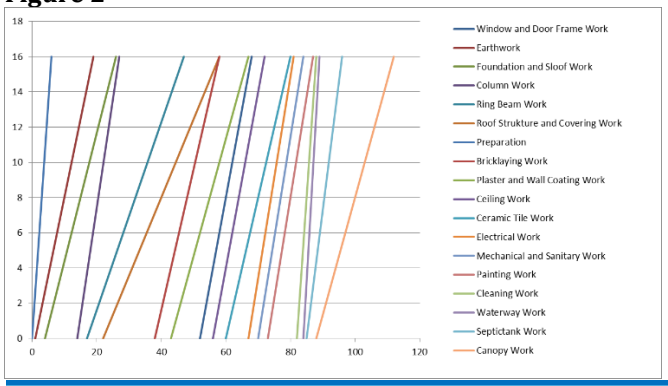

Figure 2 Scheduling using Linear Scheduling Methode after a Delay

In Figure 2, the intersection between Foundation and Sloof Work with Column work, Roof structure and covering work with bricklaying Work and Plaster and Wall Coating Work, Tile Work with Electrical Work, Mechanical and Sanitary Work intersects with Electrical and Cleaning Work, and Painting Work with Electrical Work and Cleaning Work does not exist anymore. The changes are achieved by delaying some intersects work items at the start of the graphic. First, the column work is delayed for 5 days, followed by the other works that still intersect until a graphic with no intersects work is achieved.

The changes will make it easier for the stakeholders of this housing project to execute, supervise, and control the work to be completed on time.

4. DISCUSSION

Referring to project time analysis achieved by using linear scheduling method (LSM), the results are as follows:

1) Using LSM as a scheduling tool provides convenience in planning, executing, and controlling every work item for any project party to find the project progression.
2) Using the LSM can point out the overlapped or intersected works so that scheduling changes can be done to avoid work item intersection and ease the execution of work.
3) The schedule change to avoid intersection between works caused longer work execution from 86 days to 112 days. This matter gives a longer time to complete the task. Therefore, it is expected that the work quality will be far better.

The change of the LSM graphic to avoid intersections between works by delaying work items can be done by trial and error. However, it must consider logical and productive aspects so that an excessive project execution time does not occur because it is disadvantageous for many parties, especially the client who wants to buy a house.

5. CONCLUSION AND RECOMMENDATION

5.1. CONCLUSION

The time result of using a Linear Scheduling Method (LSM) to complete 16 (sixteen) units of houses in Payodha Residence is 112 days.

5.2. RECOMMENDATION

For projects with repetitive work, the Linear Scheduling Method (LSM) can be used as a method to make a project schedule because it is convenient as a reference to execute, supervise, and control the project.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

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