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IMPLEMENTATION OF 4D BUILDING INFORMATION MODELING (BIM) ON THE FLAT BUILDING PROJECT OF BBPJN XI/PJN I KALIMANTAN

Akhmad Hafizurahman dan Husnul Khatimi

Civil Engineering Program, Faculty of Engineering, Lambung Mangkurat University
E-mail : hafiz06.r@gmail.com; hkhatimi@ulm.ac.id

ABSTRACT

The BBPJN XI/PJN I Kalimantan Flats construction project only applies manual scheduling in the form of an S curve. This building consists of 9 floors with reinforced concrete material. Currently, there is BIM technology that can minimize problems caused by manual scheduling in controlling time. So in this study, a study will be conducted on the application of 4D BIM-based project scheduling using the Tekla Structures 2020 software from manual project scheduling.

The building modeling refers to the plan drawings, including piling and reinforced concrete structural work in the Tekla Structures 2020 software. Scheduling is made using the Task Manager extension found in Tekla referring to the RAB, S curve, and interviews with the project party. The modeling results are then inputted into the Task Manager to provide 4D visualization with the help of the Object Representation extension combined with the Project Status Visualization extension.

Based on the results of monitoring project progress (tracking) inputted into the Task Manager, it is known that lower structural work was completed two weeks earlier. Upper structural work started from the ground floor starting one week earlier, and all structural work was completed 16 days earlier than scheduled plan. The duration of the work generated by Tekla Structures 2020 is 126 calendar days. The work starts from October 19, 2020, to February 21, 2021. So, with several extensions owned by Tekla, it can be said that the use of Tekla Structures 2020 software in the implementation of 4D BIM can be relied on for monitoring and minimizing errors in scheduling.

Keywords: Scheduling, 4D BIM, Tekla Structures 2020, Task Manager, tracking.

1. INTRODUCTION

In general, projects at companies still rely on manual scheduling and are not yet computerized. Hence problems arise, such as an uneven division of work activities, ineffective division of working hours, and the workforce used being prone to errors (Ferdyawan & Hajjah, 2020). Optimization problems that arise due these conditions can cause delays and even failure of a project. Currently,

there is BIM (Building Information Modeling) which is an information technology that can study buildings without having to build the first (Berlian et al., 2016). Tekla Structures 2020 (from now on referred to as Tekla) is a BIM software with built-in object-based 4D tools, which means that the imported schedule will be associated with 3D building model objects. One of the benefits of 4D BIM is that it can produce a visual representation of time, show project status, provide a virtual simulation project, and even provide a physical view of building completion at various points in time (Jiang, 2011).

In this study, the object that will be used is the BBPJN XI/PJN I Kalimantan Flats. This building consists of 8 floors with a vertically repeating design that contains 95 housing units and other facilities, and a roof-shaped deck that functions as a garden. The material of this building generally uses cast-in-place concrete in the construction process. In scheduling, this project only applies manual scheduling in the form of an S Curve. So, in this study, a study will be conducted to compare 4D BIM-based project scheduling with manual project scheduling.

2. THEORITICAL STUDY

Building Information Modeling (BIM)

The role of BIM is very important in construction to providing complete information about buildings. Every aspect and stage in the construction can be displayed with various dimensions ranging from 3D to 7D. So that through BIM technology, any conflicts that may occur when setting up a construction project can be identified before the project starts.

BIM 4D Project Schedule

Project Schedules linked to 3D models can be created and simulated virtually. BIM 4D is very useful as a visual communication tool for all construction processes to the parties involved in the construction. With the BIM 4D, planning, coordination, and supervision of project work can be improved.

Tekla Structures 2020

According to Saputri (2012), Tekla, as a BIM-based software, can create 3D

models and manage the data accurately and in detail. Tekla can assist with the execution and inspection of project data. One of the extensions available in Tekla, the Task Manager, can generate an output schedule for a project and connect it to a 3D model.

Project Management

Project management has been developed since ancient times to meet project objectives. The project objectives that must be met are mainly performance, cost, and time. These three things cannot be separated from construction management. Management is needed to manage the resources used to be effective and efficient so that the results obtained are satisfactory (Rani, 2016).

Project Schedule

The project schedule generally provides information about the planned start and end times, duration, progress, and resources. There are several types of conventional scheduling that are often found in construction implementation. Bar charts present scheduling with bar charts showing job activities. Then there is an S curve that displays the schedule in the form of a graph of the relationship between time and accumulated project progress. Another form of the conventional method is PDM, which applies activity diagrams with activity relationships between activities, namely Start-to-Start (SS), Start-to-Finish (SF), Finish-to-Start (FS), and Finish-to-Finish (FF).

Project Time Control

Time control in the project needs to be done to minimize all deviations that can occur during the project process to produce a good performance at each stage (Sanaky et al., 2015). There are several scheduling media that are widely used to control time, such as the S curve and daily/weekly/monthly reports. Meanwhile, in BIM-based Tekla scheduling, there is Trimble Connect which can present all models completely on other devices for control purposes.

3. METHOD

The research method is presented in the flow chart below:

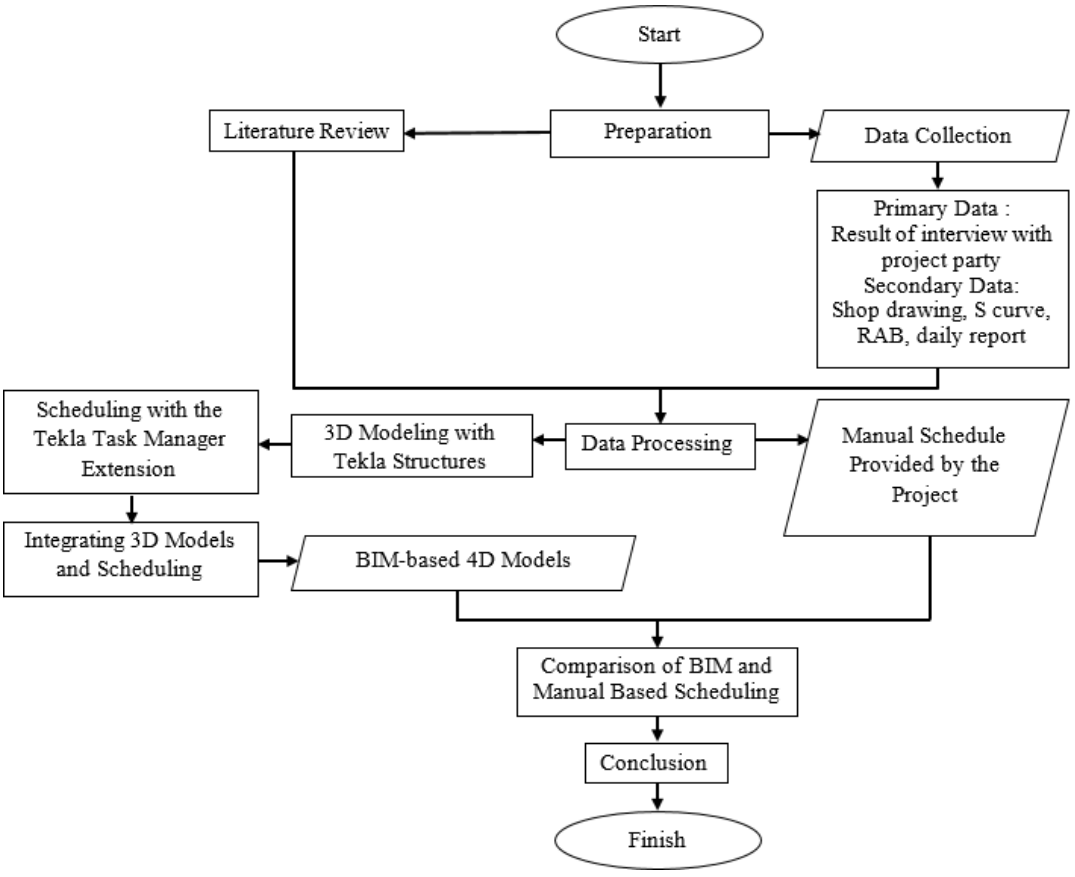

Figure 1. Flow Chart

4. RESULT AND DISCUSSION

5. Modeling on Tekla

The modeling is made using the Tekla Structures 2020 software with a South-East Asian environment because the project location is in the Southeast Asian region. Shop drawings are used as a basic reference for modeling. The first step starts with creating a grid and the type of material used. The modeling made in this project is a reinforced concrete building consisting of pile caps, piles, tie beams, beams, columns, and floor plates. The results of the modeling are shown in the following figure.

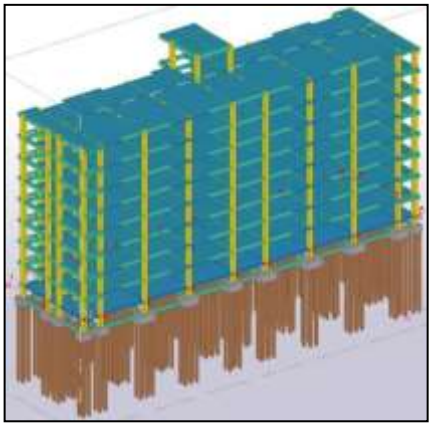

Figure 2. Modeling Results on Tekla

Tekla Organizer

Organizer functions to classify the modeling of objects that have been made previously; in using the Organizer in the form of a list, the entire model is then classified into several main categories to sub-categories. In addition, the Organizer window also provides additional information in the form of material type, profile, height, length, width, volume, position. Scheduling will facilitate the selection of objects integrated into the 4Dmodeling.

Scheduling with Tekla Task Manager

Scheduling is made from existing project data; from the S curve, a Work Breakdown Structure (WBS) can be made. The WBS used is based on interviews from the project as primary data and the Budget Plan (RAB), S curve, and daily reports as secondary data. Through the results of interviews, obtained data on the duration of work, dependence, and implementation time. Furthermore, the RAB work items that are taken are only according to the model object that has been created by Tekla. The duration of the Tekla Work is inputted manually in the Tekla schedule, while the Tekla volume is obtained from the Window Organizer; by selecting the category list that has been created per group of objects, Tekla will add them up and input automatically based on the 3D model that has been created.

Similar work items with the same duration are grouped and coded, then from the interview, a table with constraints (constraints) based on previous work (predecessor) is made. Dependencies between jobs indicate when the next job

can be done. In the Task Manager, there are four dependencies between jobs similar to PDM, namely, start to start (mSSn), start to finish (mSFn), finish to start (mFSn), and finish to finish (mFFn), where m is the code from the previous job and n are lead time and lag time. The data for scheduling that has been entered into the Task Manager can be seen in the image below.

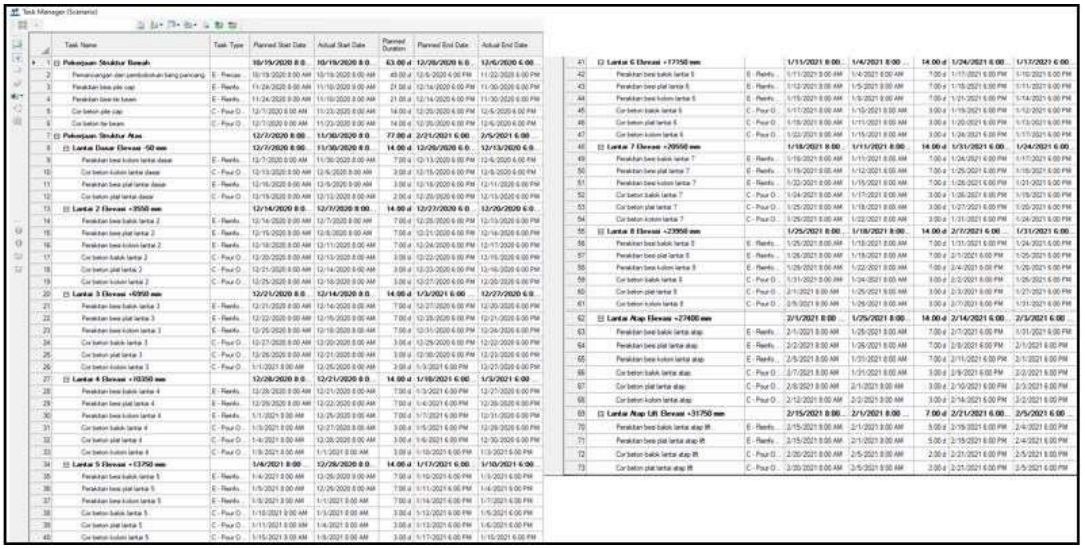

Figure 3. Input data in Task Manager

The next step is to unify the 3D model with scheduling data in the Task Manager using the Organizer to become a 4D model. The output of Tekla scheduling is in the form of a bar chart with date ranges and dependencies and different colors; blue shows the planned time duration and yellow for the actual/implementation time duration as shown in the following figure.

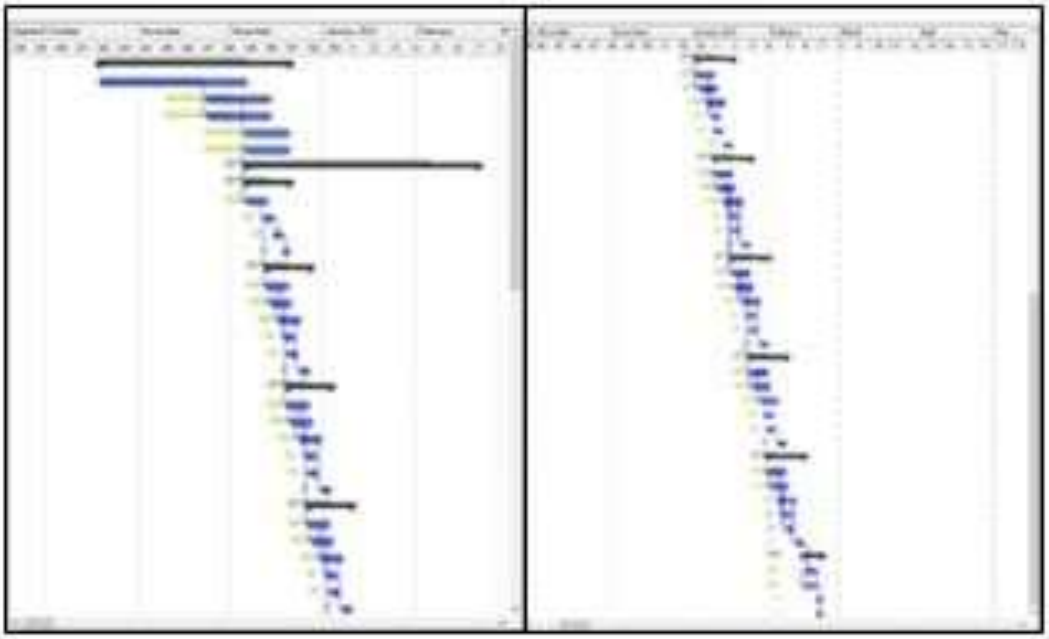

Figure 4. The Output of Tekla Task Manager

4D Visuals

4D visuals can show which parts have been completed, are being worked on, or have not been done according to the date reviewed. The results can be seen in the following image.

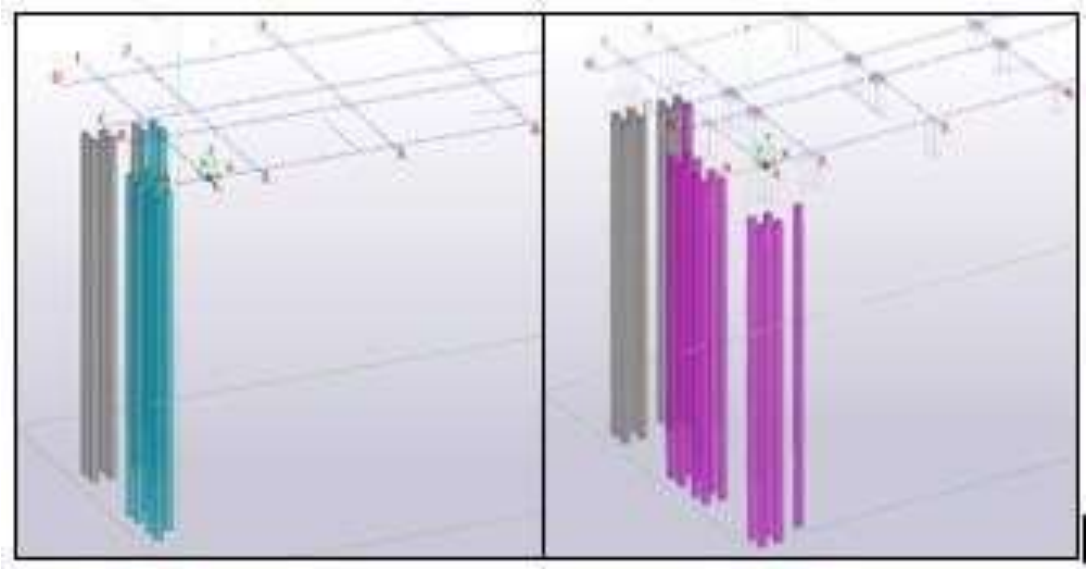

Figure 5. Visualization of Planned Duration (left) and Actual Duration (right) on November 24, 2020

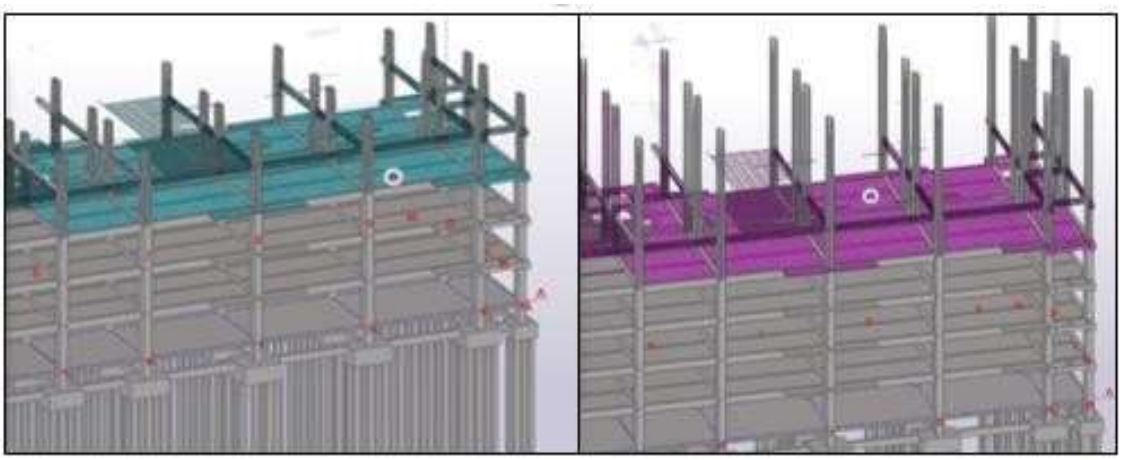

Figure 6. Visualization of Planned Duration (left) and Actual Duration (right) on January 4, 2021

Figure 7. Final visualization of Actual Duration on February 5, 2021

Results and Comparison of S Curve Scheduling with Tekla Task Manager

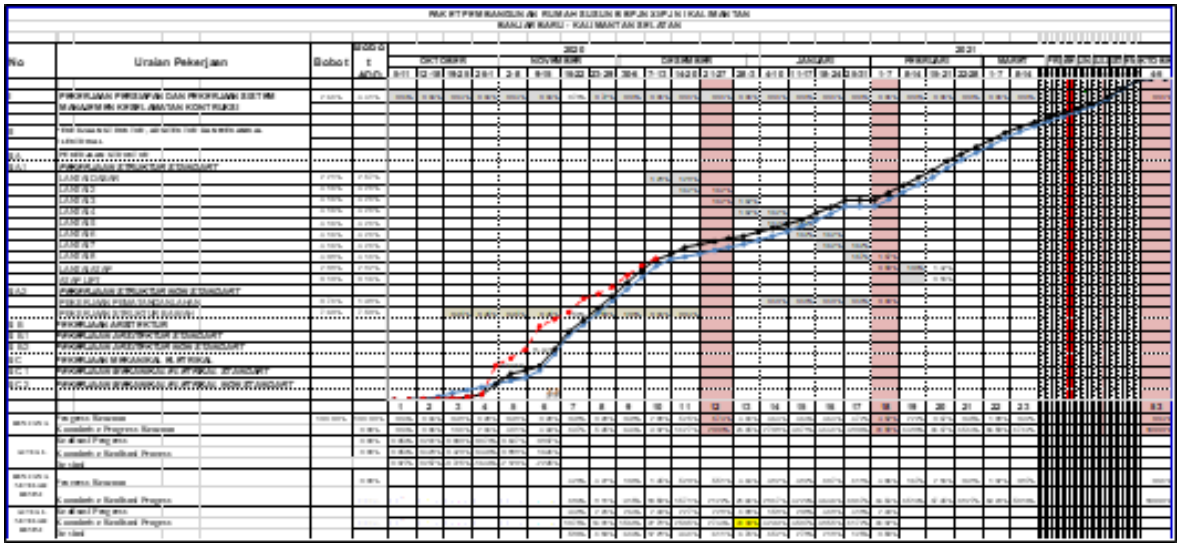

Figure 8. S curve of the BBPJN XI/PJN I Kalimantan Flats Construction Project Flats that have a vertically repeating design make it easy when doing 3D modeling on Tekla because floors with the same design can be copied to the next floor at a different elevation. From the S curve obtained from the project party in Figure 8. it can be seen for structural work, starting from October 19, 2020, to February 21, 2021, 126 calendar days were obtained. In the Tekla Task Manager output from Figure 4. it is known that for all scheduling, starting from the piling and pounding work items up to the elevator roof floor work item completed, a total time of 126 calendar days is obtained, such the S curve. So it can be seen scheduling using the Tekla software was successfully carried out by applying the manual scheduling of the S curve obtained from the project.

The advantage that Tekla's S curve scheduling doesn't have is the Task Manager extension. This extension is used to create a schedule by inputting the start date of the work, then proceed by making dependencies between activities with the FS, SF, SS, and FF relationships that are not found in the S curve schedules obtained from the contractor. Very complex dependencies on large projects such as flats can be overcome by utilizing this extension, as opposed to doing it manually. Scheduling is also easy to modify if desired changes in the

schedule or if there may be changes, either additions or deletions in the project building. It is already tied to 3D models and dependencies so that the schedule will adjust itself or be adjusted directly by the user. The Task Manager can also monitor project progress more thoroughly by adding the actual start date and actual end date of each work item to the schedule to help with monitoring. From the monitoring results, it is known that the lower structural work was completed two weeks earlier. The upper structural work was started from the ground floor one week earlier, and all structural work was completed 16 days earlier than the planned schedule. The results of the Tekla schedules are displayed in the form of a bar chart with an adjustable date range. Models can be synchronized against a job list or per model object, which can be sorted by the part of the model that was worked on first. So, it can be seen through the Task Manager, scheduling in Tekla can provide some data such as list of work items, time duration, dependencies, bar charts, work progress. In addition to the things described above, scheduling in Tekla also produces other data such as total work volume, plan productivity, and productivity during implementation. This can be used as a reference for further work in maximizing the use of existing resources so that they are not excessive. For example, when there is work ahead of the planned duration, Tekla can show that the productivity value during execution is greater than planned and results in faster project completion times. By providing a display of the duration of the work along with the allocation of resources needed, scheduling can also be effective and efficient.

In addition, for 4D visualization, Tekla has an Object Representation extension to create visualization logic capable of displaying the stages of work with the visualization logic that has been created. This report shows which parts have been completed, are being worked on, or have not been done. Logical order can be sorted according to visual priority. Furthermore, Tekla uses the Project Status Visualization extension to display 3D modeling according to the date to be reviewed. Project Status Visualization can view the date review according to the day variable or shift the timescale. There are still some drawbacks to scheduling through the Task Manager in Tekla, such as not showing the critical path, which

is an important part of scheduling. The working hours of each day also cannot be inputted, so work that requires overtime cannot be added to the schedule. In addition, the deviation between the progress of the plan and its realization also does not appear automatically. So, other applications that can integrate with Tekla, especially those that focus on scheduling, become necessary to support Tekla's scheduling for the better.

6. CONCLUSION

The results of scheduling through Tekla by applying manual scheduling of the S curve obtained from the project are 126 calendar days, and based on the results of monitoring the progress of the project, which is inputted into the Task Manager; it is known that all structural work was completed 16 days earlier than the planned schedule. The difference between Tekla scheduling and the S curve is in the extensions that Tekla has to assist in scheduling, such as creating 3D models and connected schedules into a single unit, schedules can be modified as needed, adding dependencies for each complex work item on large projects, helping the process of monitoring project progress, the allocation of time and resources needed are shown, and Shows a picture of the state of the project according to the date of the review. Additional applications in scheduling are needed to support Tekla to produce a perfect schedule.

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