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Construction Project Planning and Scheduling: A Case of Inlet Separator Fabrication

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ABSTRACT: Project construction activities must be analyzed from the planning stage to the execution stage so that they can be achieved optimally and achieve the best performance point. Project planning relies on a project scheduling system, of course requiring updates and modifications that show the project conditions in real time. The aims of this paper is propose a project scheduling system that can accommodate projects that have large-scale activities by proposing scheduling and risk analysis using Primavera P6 and Primavera risk analysis. A case study was conducted on the construction of an inlet separator fabrication project in Batam, Indonesia. The proposed method aims to calculate the optimal project completion time through automatic scheduling with primavera software. The method demonstrates practical value for project managers in identifying the shortest project duration and estimating the most optimal time duration for carrying out activities. In addition, using automatic scheduling can provide more complex information including successors and predecessors of activities, critical times, estimates of the overall duration of the project.

KEYWORDS- Optimization, Schedule generation, Construction, Project Management, Primavera

I. INTRODUCTION

Construction activities have existed since humans began to build their homes, then created many wonders in the world and produced many facilities for the benefit of mankind. The construction industry is an important element for the country's economy, therefore construction industry projects must implement effective project management (Kohli, 2017). The construction industry, especially in Indonesia, has faced a very competitive business challenge, the more complex projects carried out and highly demanding clients are one of the main problems for contractors (Hartono et al., 2017). Thus, companies must be able to manage the main problems for the organization to create project success and achieve the best performance point. Traditional indicators of success in project management refer to the owner’s quality requirements, cost compliance and delivering the project on time (Locatelli et al., 2017; Wang et al., 2021). But other researchers also argue that the nature of project success is multidimensional with different criteria and only a few can be clearly measured (Williams, 2016).

Indonesia has various types of construction projects carried out by firm on a regular basis, for example, offshore and onshore oil drilling construction projects. The construction project certainly cannot be separated from the contractor firm that helps to facilitate the supporting components in oil drilling. The components must have criteria that are in accordance with the specifications and standards required, for example the product must last more than 10 years, be able to withstand strong loads and withstand heat and have international standards. The components or tools needed by the company in carrying out drilling include land rig upgrade, FDPSO modules, vessel (inlet separator), jack up legs, and fuel gas project. With the diverse needs for tools needed by offshore or onshore firm in carrying out oil drilling, of course, contractor firm have projects that are in such a complex way or can be called mega projects. To meet this demand, the construction projects that are carried out certainly require careful planning, scheduling, and project execution in order to achieve timely project completion performance.

The construction industry, especially in Indonesia, has faced a very competitive business challenge, the more complex projects carried out and highly demanding clients are one of the main problems for contractors (Hartono et al., 2017). Thus, companies must be able to manage the main problems for the organization to create project success. Traditional indicators of success in project management refer to cost compliance, on time, and according to specifications(Locatelli et al., 2017). But other researchers also argue that the nature of project success is multidimensional with different criteria and only a few can be clearly measured (Williams, 2016). Therefore, it is necessary to have the right analysis to examine and review the project scheduling

process as well as the estimated time specified in the implementation of activities using computerized-based technology, such as Primavera P6 and Primavera Risk Analysis to maximize activities to achieve superior project success.

Construction project is a managerial environment created to create one or more specific products according to business demands (Berjis et al., 2020). The need for change in construction practices has been discussed and attracted the attention of many scholars and practitioners (Le & Nguyen, 2021). Construction project involves a lot of activity and needs to be planned and estimated correctly to find out the time needed to complete the project. It is necessary to estimate the completion of the project so that it can be seen how big the chance of the project will be completed according to the schedule that has been set (Heizer et al., 2017). Several traditional methods have been developed to deal with the implementation of construction projects, including using the CPM (Critical Path Method) and PERT (Project Evaluation and Review Technique) method (Heizer et al., 2017). By using this method, it can be seen that every activity that is in the critical path, activities on the critical path are activities that must be monitored in such a way because if they are left behind or late, it will have an impact on delays in the completion of the project as a whole. In addition, by using this method, we can also see how big the opportunities will be in pursuing the implementation of projects that are in accordance with the target. By knowing the opportunities that exist, it will become a material for consideration for the project team to decide what efforts will be made in pursuing the project completion target.

Planning and scheduling are very important aspects of implementing construction projects (Athani & Kulkarni, 2018). A project involves a lot of activity and needs to be planned and estimated correctly to find out the time needed to complete the project. Previous research (eg, Polekar & Salgude, 2015) revealed that traditional project management systems could no longer meet the demands of the current project because most information and data about a project were constantly changing. According to Gharaibeh (2014) revealed that in the current era the industrial revolution in the field of computer software has been very rapidly developing, making managers working in engineering industries such as the demand and gas industries can no longer ignore facilities and equipment in computer technology if they want superior. Based on the findings of previous studies (eg. Gharaibeh, 2014); Polekar & Salgude, 2015), this study aims to provide alternative rock by adopting the role of computer software to overcome the limitations of traditional project management systems. Various software developed to improve various projects, ranging from design, marketing, architecture, engineering, construction to cost estimation, and scheduling (Gharaibeh, 2014). This study will discuss software used in project scheduling activities related to Primavera P6 software and very effective risk analysis used to schedule project activities so that it can be used to improve projects with resources and scheduling it's easier to watch as you start the project. To fulfill the research objectives, this study will discuss project completion time estimates after rescheduling and discussion of critical activities and completion of project approvals. In the first part of this paper, the introduction will be related to project scheduling, the second part will discuss the literature review that supports the implementation of project management, the third part will present the research methods and the sections related to the research findings. This research will conclude with managerial implications and limitations of subsequent research and research.

II. LITERATURE REVIEW

The construction industry is largely project-based, with current production theory and practice still heavily influenced by project management concepts and techniques that are certainly growing with modernization (Belayutham et al., 2021; Khoso et al., 2021). Project management requires knowledge, skills, tools, and techniques for project activities that meet project requirements (PMBOK, 2013), project management will produce results for the interest and manage various activities that must be addressed (Bordley et al., 2018). According to Bordley, Keisler, & Logan (2018), project management must provide support for all work activities that must be completed to achieve project results, and determine which activities should be carried out before other activities begin.

In project management practice, the delay in completing the project is a major problem that is needed and needs to be managed to improve the final project (Guida & Sacco, 2019). Delayed schedule is a traditional problem in almost all projects and sometimes delays unavoidably lead to serious conflicts between owners and general contractors in construction projects (Guida & Sacco, 2019; Türkakın et al., 2020). According to Heizer et al., (2017) PERT and CPM had been developed in the 1950s to help managers schedule, check and control large complex projects. CPMs that lend at the time spent by the project by removing additional resources on critical path activities or transferring resources from non-critical paths (Bordley et al., 2018). The CPM assumes nothing has been agreed to in the duration of each activity (and does not have priority in the completion of one of the project lines) (Heizer et al., 2017).

PERT generalizes CPM by acknowledging the uncertainty in the time needed to complete various project activities (Bordley et al., 2018). PERT proposes to anticipate this uncertainty by using a beta distribution to illustrate the uncertainty of completion of activities (Heizer et al., 2017). However, in the rapid advances in technology has shifted practical project management based on documents to be computerized, for example by using software to schedule activities.

III. RESEARCH METHODS

This research is a type of applied research, which uses observations and case studies in data collection (Cooper & Schindler, 2014) that support to provide input for professionals based on the results of the study. This research takes a case study, in which case studies were taken in this study discuss one of the companies incorporated in the oil and gas construction industry in Indonesia, especially for inlet separator oil and gas projects discussed in Riau Islands, Batam.

This study took a sample of research on the island of Batam on the grounds that this island is one in Indonesia which has many industrial sectors that are clustered and the only province that has existed in the era of free trade. This study examined the scheduling of the work on oil and gas manufacturing projects carried out by PT. CTE in 2014, and made observations to get further insight into the phenomena that occurred in the firm within a period of 1 month in January - February 2015. To analyze the findings data this research will be conducted using CPM analysis and projects, critical paths, and probabilities duration of activity. Before conducting an analysis using CPM and PERT, this study first determines the work breakdown structures, this is to make it easier for the scheduling team to formulate the activities to be carried out, especially in automatic scheduling.

IV. RESULT AND DISCUSSION

This research is focused on PT. CTE is a subsidiary of PT. CT Tbk, which was founded in 1983 and listed on the Jakarta stock exchange in 1989. PT. CTE was established in 2007 and is located in the Kabil free trade zone, Batam island, Indonesia. PT. CTE is engaged in the construction industry (engineering, procurement, and construction). This firm fabrication for the oil and gas industry or is referred to as a client for Pertamina, Petronas etc. As for the products produced by PT. CTE consists of land rig upgrades, FDPSO modules, vessels, Jack up tutoring etc. For research needs, this research will discuss one of the projects they are working on, namely inlet separator projects (oil and gas filters). The results of this study will consistof three parts, namely, workbreak down structures (WBS), critical path analysis (CPM) and program evaluation and review techniques (PERT) using primavera P6 and risk analysis.

Work Breakdown Structures

The WBS is a basic tool for specification and categorization of work elements in project management to organize and define the total scope of a project into smaller, more manageable components (PMBOK, 2013; Toutounchian et al., 2018). Using WBS is the best alternative in organizing activities and sub-activities (Toutounchian et al., 2018). In the context of the WBS, work refers to work products or deliverables that are the result of an activity and not the activity itself (PMBOK, 2013). Below can be seen in Figure 1 WBS for the inlet separator project that has been prepared.

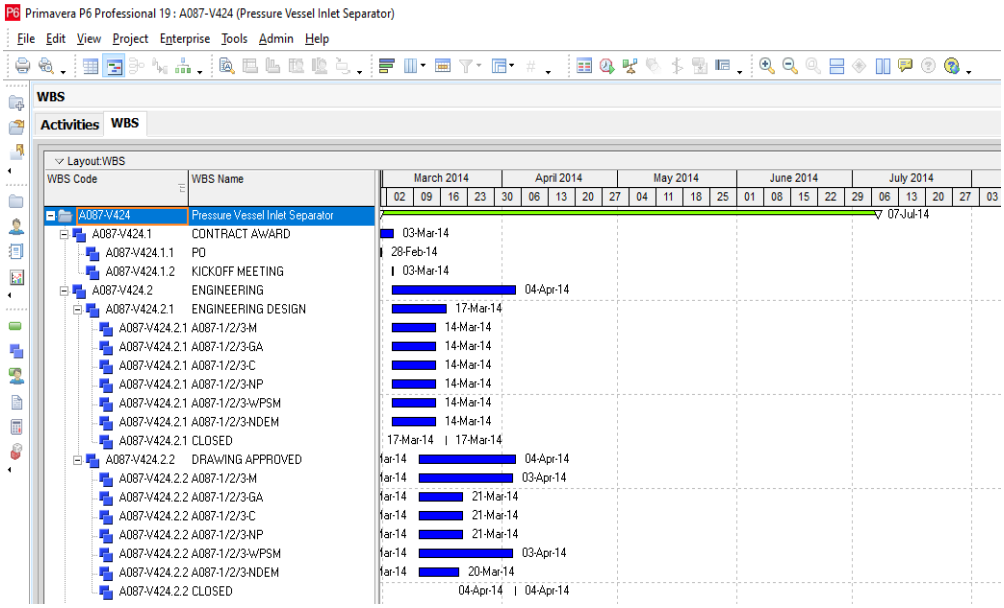

Figure 1. Work breakdown structures

Source: Processed data

Critical Path Method (CPM)

In this section will show the results of the analysis using the CPM method in making estimates related to the completion of the project, estimated completion time which will be discussed in table 1 and figure 2. Table 1 show the original scheduling for inlet separator project using ms.excel. the project with an agreement total duration is 129 days, the project estimation due date and completed on August 28, 2014. However, due to some things happening with high uncertainty, project completion was delayed until 146 days on September 22, 2014. The results of the study show that there is a mismatch in the actualization process of activities caused by various reasons, such as no approval will be made on projects that involve too many documents or problems with material delays that cannot be carried out at the agreed time. The findings of this study compared to previous studies by Polekar & Salgude (2015) that support industries in the globalization era are increasingly widespread and complicated if planning that requires a lot of documents will cause project delays. It is hoped that previous research (see, Kohli, 2017; Polekar & Salgude, 2015) supports the use of software to provide good planning, the right organization, the right resources for a project that cannot obtain the desired results.

Next, to see the effectiveness of scheduling. We use automatic scheduling using primavera P6 to see the effectiveness of scheduling estimates and re-planning of activities that can be prioritized in the project. The rescheduling results can be seen in Figure 2. Figure 2 shows the results of scheduling using the Primavera program which gets the estimated time to support the project and has an optimal time of 119 days on August 14, 2014. By better scheduling and discussing other important crucial aspects, so do the reports need to complete one activity. To find out the amount of time needed, specifically for engineering projects, deepening and various suggestions from experience are more expert in the field. This is because projects that are done, and not repeatedly made based only by client requests. Even so, various activities carried out are activities that are similar to, according to the specifications desired by the client.

Table 1. The Original Sequence of Work on the Pressure Vessel Inlet Separator Project

ID	Task Name	Predecessor	Duration	Start	Finish
1.	**A087 - GLOBAL PROCESS SYSTEM INLET SEPARATOR**		129 days	Fri 28/02/14	Thu 28/08/2014
2.	**Contract Award**	1	2 days	Mon 21/04/14	Tue 22/04/14
3.	**PO**	2	1 day	Mon 21/04/14	Mon 21/04/14
4.	**Kick Of Meeting**	2	1 day	Tue 22/04/14	Tue 22/04/14
5.	**Engineering**	4	14 days	Thu 24/04/14	Fri 09/05/14
6.	**Engineering Design**	5	14 days	Thu 24/04/14	Mon 05/05/14
7.	**Drawing Approved**	5	10 days	Tue 29/04/14	Fri 09/05/14
8.	**QA/QC**	7	19 days	Wed 30/04/14	Wed 21/05/14
9.	**Procurement**	1	73 days	Fri 28/02/14	Fri 23/05/14
10.	**Fabrication**	9	108 days	Fri 25/04/14	Thu 28/08/14
11.	**Packaging**	10	4 days	Mon 25/08/14	Thu 28/08/14
12.	**Delivery**	11	0 days	Thu 28/08/14	Thu 28/08/14

Source: Internal Firm (2014)

Rescheduling with Primavera P6 will show various activities that fit the critical path and will discuss with charts marked in red. Activities on the critical path are a large part of agreed activities and tighter supervision because it will have a direct impact on project completion. This research has re-planned to find out the impact if the activities carried out on the critical path on the completion of the project as a whole. The findings of this study indicate that, if the firm has scheduled one activity to be completed in three days, and agreed in Primavera that the activity is not in accordance with the path of criticism, the firm completes within two days the results will not complete the project. Others answered that the acceleration of completing the project on the critical path would provide conflicting results.

Based on CPM analysis in the initial stages of using Primavera P6, figure 2 shows the rescheduling activity with Primavera P6. The next stage needs to be carried out according to the critical path so that the project runs smoothly so that there is no project delay. Therefore, it is very necessary to conduct critical path analysis to determine the critical level so that every activity that must be carried out on the critical path can be done faster and without stretching time. To find out the activities carried out on

this critical feeding lane, a PERT analysis will be carried out using primavera risk analysis (PRA), which will provide an estimate of the completion time for each activity and will show the appropriate activities on the critical path that must receive attention.

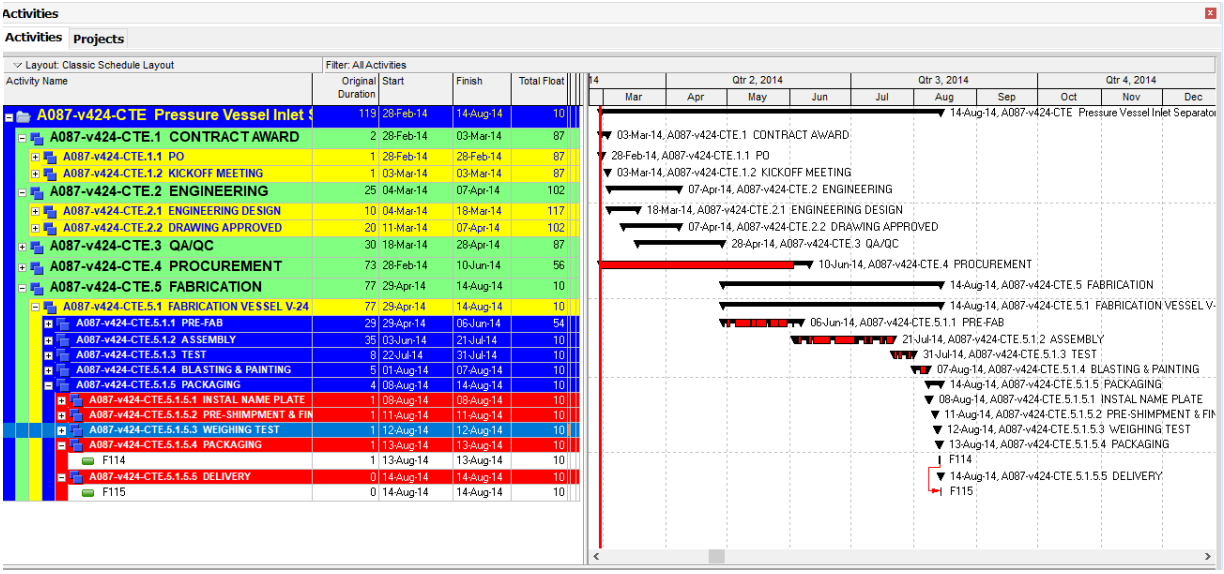

Figure 2. Rescheduling projects with Primavera P6

Source: Processed data

Program Evaluation and Review Techniques (PERT)

In this section, it will show activity lines that correspond to the critical path to reduce delays. By using Primavera risk analysis will be very easy for internal project managers to determine the time to start the project, after contracting with their clients. Primavera risk analysis will give the minimum time estimate, Mean and Mean in the best percentage of time to start a project. Primavera risk analysis results will be approved in the graph of the distribution of start date, end date and The duration in Figures 2 and 3.

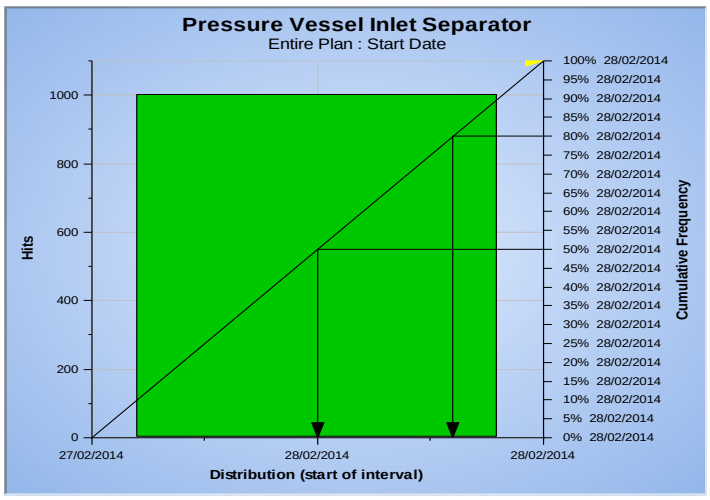

Figure 3. Distribution graph start date

Source: Processed data

In Figure 2, the results of the analysis carried out showed that the most optimal time in starting the project on February 28, 2014 with probability 100 per cent, after reviewing the reason that Primavera risk analysis sought to start work on the date specified in accordance with the project, displays some activities that a waiting time of up to 1 month is required, namely the purchase of materials from abroad. Required, a risk analysis issued by the company to immediately order the material well before the project starts, to reduce the rehearsal completed by the environment that will occur, because the material purchased is heavy equipment and must use sea lanes to make deliveries. After completion, the results of the analysis of the completion will be completed in Figure 2.

In figure 3, project completion time on 3 occasions, namely maximum, minimum and optimal time. The convenience offered by Primavera risk analysis provides several options for the most optimal settlement team to be carried out, not only at the time of

the entire project but at providing optimal time options for each activity. Based on the results of primavera risk analysis, results shows the best time for the project to be completed on 08/10/2014 and the most optimal on 24/09/2014. From the results of this analysis there is a significant difference between automatic scheduling using primavera p6 and the use of primavera risk analysis. Automated scheduling using primavera P6 results in faster project completion estimates than traditional scheduling performed by project management teams. However, the results of the scheduling estimates carried out are very far from the completion time of the project in the field, the traditional schedule assumes the project will be completed on 14 August 2014, however there is a delay in completion until 22 September 2014. Based on the results of primavera risk analysis, there is a significant match between the estimated project completion and the actual situation of project completion in the field. Thus, it is better for companies when scheduling a project to conduct a primavera risk analysis before the project starts.

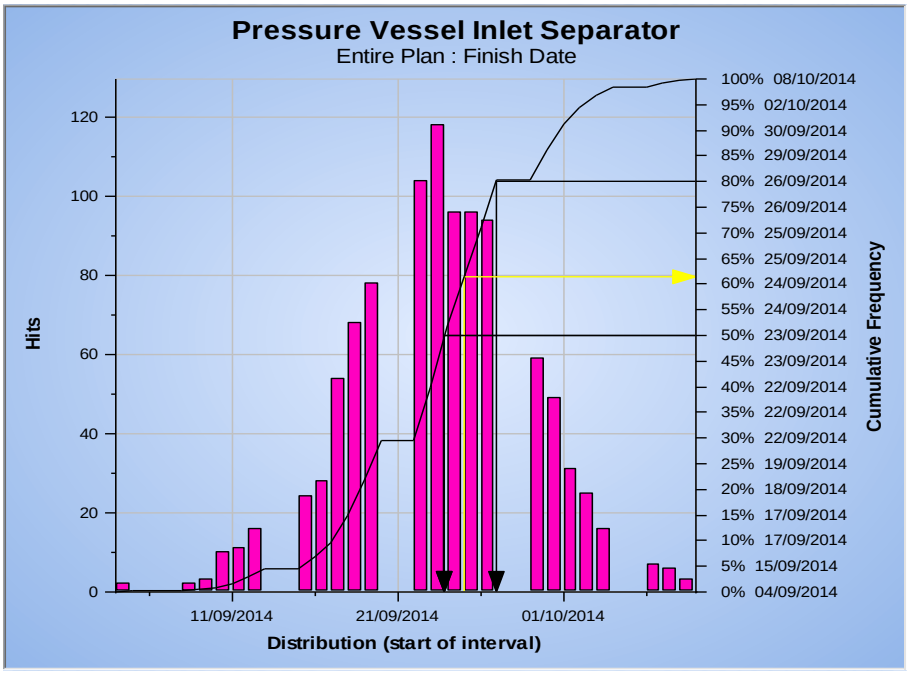

Figure 4. Distribution graph finish date

Source: Processed data

V. CONCLUSION AND RECOMMENDATION

CONCLUSIONS

Research relating to the oil and gas industry is categorized in the EPC industry (engineering, procurement, and construction) but is often widely known as a construction project. Project implementation in Oil and gas is a very complex project and has a project management system that emphasizes safety standards, rules, and regulations, which are specified in the contracting environment (PMBOK, 2013). This research contributes theoretically to PMBOK's best practices for the EPC/construction industry, especially those relating to the identification of the phases of the implementation of oil and gas projects.

In identifying the project implementation phase, with the help of Primavera software, this will provide theoretical new insights that traditional project management systems cannot support changes in oil and gas projects, especially in the era of the industrial revolution (Polekar & Salgude, 2015). Therefore, new skills and knowledge are needed that must be obtained by the project management team to ensure that the processes they carry out to complete the project are still relevant to existing technological changes. Changes in technology lead to a reduction in many activities that experience downsizing and require a person who has high creativity and is open to making system changes. In addition, this study also contributes to the literature of knowledge management tools, whereby adopting new technologies that are used to better target content to personnel who have a cognitive capability in absorbing new knowledge which is then applied in project implementation (Dalkir, 2005), such as applying evaluation and scheduling of projects using Primavera.

Using project evaluation and scheduling will enable the company to get tacit knowledge transfer (Dalkir, 2005) which is owned by various personnel who have experience in working on and estimating the amount of time needed to make the tacit knowledge owned by the company explicit. This research also has a practical contribution that in project management has controls that have close monitoring of resources, costs, quality, and budget. Therefore, the controls carried out can be used to provide feedback as well as revise the project plan and have the ability to divert resources to the right portion. Using a computerized CPM/PERT chart report (Heizer et al., 2017), raw material expenditure, time analysis reports, employment status

reports, and scheduling will provide practitioners with various facilities, such as; details of costs, labor requirements, cost summaries and hours. In this study, which focuses on project management, especially scheduling activities, it shows important findings that computerized scheduling will simplify work and provide more specific results. More specific results are shown in the results of the analysis which show that scheduling projects with Primavera will provide clearer and more systematic project completion targets and provide various kinds of risk analysis that can be considered by the project team in making decisions.

The results of re-planning in this study, consistent with previous studies (eg Athani & Kulkarni, 2018; Kohli, 2017; Polekar & Salgude, 2015) which emphasize that scheduling using Primavera software will facilitate the task of the project team in scheduling and evaluating activities and make it easier for teams to control the pace of activities that are on the critical path for accelerated activities.

Based on the results of CPM analysis using Primavera P6, the estimated project completion results look close to traditional scheduling. However, there is a fundamental difference between automated and traditional scheduling. In traditional scheduling, especially with large-scale projects, the management team will find it difficult to determine the critical project size and optimal time due to the large number of activities. Especially in the pressure vessel inlet separator project, there are 379 activities that must be carried out. Due to the large number of activities to be carried out, automatic scheduling using Primavera P6 will make it easier for the project management team to determine which activities are predecessors or successor and which activities can be accelerated by looking at the critical path. Primavera p6 will show activities that are on the critical path, then the project management team will find it easier to reschedule activities on the critical path, to find the most optimal scheduling. The results of the Primavera P6 analysis in this study show the same time as the target desired by the company will be completed. This is because, in rescheduling using primavera p6 which was carried out in this study, no rescheduling was carried out based on accelerated critical path activities. For this reason, future research can expand the study by rescheduling based on the critical path to see advanced completion times.

Different from primavera p6 scheduling, primavera risk analysis provides more interesting findings. This can be seen in the results of the risk analysis which show a significant similarity between the completion of the project in the field compared to the results of the project estimate. Estimated project completion that is close to project completion in the field, causing the emergence of an interest for the project team to conduct a risk analysis before executing the project. By knowing that project completion will not be completed according to the company's initial expectations, the project team can reschedule based on critical path analysis to get the project completion time to match the target. Furthermore, the research findings show that primavera computerized scheduling provides more efficient scheduling and provides a variety of conveniences. Therefore the findings of this study support previous research (for example, Gharaibeh, 2014; Kohli, 2017) which emphasizes that in the current industrial revolution it will be very beneficial to utilize computerized technology to facilitate project implementation. Furthermore, supported by Gharaibeh's (2014) research, emphasizing overall software programs used in project activities will provide solutions that will assist in the completion of projects that are faster, lower costs and increase productivity and job accuracy especially in the engineering industry, such as Oil and Gas. For this reason, utilizing computerized based scheduling will contribute to improving company performance and increasing project success (Locatelli et al., 2017; Rosacker et al., 2010).

This study has several limitations to the study, first, this study was designed with applied/qualitative research which emphasizes more on digging information from informants, then rescheduling the project's ext-pose has not been able to provide strong reasons to specifically prove project delays caused by late activities. Future research seems to be needed to test the aspects of personal behavior as one of the causes of project completion delays (Teasley et al., 2012), by testing the personal side it is expected to provide broader insights for research in the future come. Second, this study only evaluates one project within the company, so that it has a small scope, so that future research can explore the mega project so that it has more qualified and relevant theoretical contributions in the changing industrial revolution(Locatelli et al., 2017). Research related to the Oil and gas industry that promotes occupational health and safety (PMBOK, 2013), therefore future research will be very interesting to examine related safety indicators in the Oil and gas industry project (Toutounchian et al., 2018).

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