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Time Cost Trade-Off Analysis on The Sumobito Health Center Rehabilitation Project

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ABSTRACT

This research examines ways to accelerate projects using the Time Cost Trade-Off (TCTO) method, supported by Primavera P6 software. The goal is to find the best balance between time and cost for rehabbing the Sumobito Health Center building in Jombang, a key public health spot that needs to be done faster without blowing the original budget. It zooms in on the main structural tasks along the critical path, pitting two speedup options against each other: one, tacking on 3 extra hours of overtime daily; two, boosting the workforce. The simulation results, laid out side by side, reveal that both approaches cut the project to 135 working days, shaving 15 days off the usual 150-day timeline. On the money side, the overtime route comes to Rp 4,004,863,761.46 (excluding VAT), which is cheaper than the worker-boosting plan at Rp 4,031,275,898.99 (excluding VAT). From the charts, overtime comes out on top as the smartest move, slashing the schedule while keeping expenses under the baseline budget. Overall, this study offers a practical, data-backed framework for contractors and project teams to identify effective, measurable ways to fast-track rehab jobs in public health buildings.

Keywords: *Critical Path; Time Cost Trade-Off; TCTO; Primavera P6; Project Acceleration; Time and Cost Optimization.*

1. Introduction

A construction project is a set of construction activities that require equipment and human resources, managed to ensure that time limits can be planned to achieve goals [1]. Projects that are a series of several activities or activities with a certain period of time and are responsible for managing the resources used with certain methods to achieve a goal [2]. This method can be done through scheduling, which is important to pay attention to because it regulates the flow of labor, materials, and capital for project sustainability [3]. Accurate scheduling is crucial to avoid work errors, and it can support project evaluation [4]. Project scheduling is in the form of an S Curve, which can display information about project progress by comparing planned schedules to identify acceleration or delays [5]. Project management is the endeavor to plan, coordinate, lead, and oversee business resources to accomplish predetermined short-term objectives as effectively and efficiently as possible. To achieve this goal, project scheduling and control must be carried out as accurately and optimally as possible [1]. A project is considered successful if it is carried out within short costs and time; therefore, a good project management plan must be in place before the project is implemented [6]. Time, quality, and cost are interconnected factors that determine whether a project will be completed on schedule, within budget, and meet the minimum quality and cost requirements outlined in the project plan [7]. To achieve project success with these three

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elements, companies must have a project-planning method that optimizes the use of existing resources while avoiding penalties for delays in project completion. This method focuses on control during project implementation, aiming to use human resources, information, funds, technology, facilities, materials, and equipment more effectively and efficiently [8].

One technique is the Time-Cost Trade-Off, a control strategy that balances time and cost. These two factors affect a project's success or failure, which is typically evaluated quickly, with little funding, and without sacrificing the caliber of the work [9]. If a project is well managed, it can be completed on time and according to the plan. The goal of project control, one of the project management functions, is to ensure that every task is completed successfully and efficiently. [10]. The three main elements in project implementation are cost, quality, and time [8]. If fewer resources are available than planned, the project duration may be delayed. Time delays in project activities will be inherent in funding. Increasing resources, labor, and materials will increase funds but speed up construction [11].

Prior studies demonstrated that the TCTO approach reduced the typical duration from 24 days to 128 working days, saving 128 working days compared to the typical duration of 152 working days [12]. In other research, it was also found that using the TCTO method in the PT Pertamina mooring boat project could also be completed 5 days faster than the estimated project time [13]. Even in research on ammunition warehouse projects, the use of the TCTO method could optimize time by 34.69% and optimize costs by 4.24% [14].

The rehabilitation project for the Sumobito Community Health Center building was planned to be carried out in 150 working days on 2 floors. Such projects require detailed project management, including planning, scheduling, and control evaluation, for both large and small jobs, to identify the most efficient time and cost trade-offs and accelerate project completion. Given that the community health center is a health service facility for the general public and closely related to the wider community's interests, it is hoped that the project's completion will be accelerated. This research aimed to calculate the costs incurred when duration acceleration occurs, determine the time elapsed after duration acceleration, and analyze the optimal time and minimum costs for the Sumobito Community Health Center Building Rehabilitation project.

The software used is Primavera Project Planner 6.0 (P6), which supports project planning and management, from initial planning to the creation of graphic networks [15]. Primavera is very flexible in managing many activities, and real-time reporting provides meaningful data quickly, well, and on schedule [16]. Using Primavera P6, this research focused on increasing working hours and work shifts (3 hours) as an alternative to accelerate projects while minimizing cost overruns.

2. Material and Methods

This research was conducted at the Sumobito Community Health Center in Jombang Regency from September to October 2021. The Sumobito Community Health Center building rehabilitation project, with a target completion time of 5 months from July to December 2021, served as the author's research object. In this study, two variables were employed: the independent variable, namely cost control, and the dependent variable, namely time optimization. Various data for the research were collected directly from project contractors in the field. This data included Time Schedule (S-Curve) plans and realization, Cost Budget Plan (RAB) for bids, indirect costs, direct costs, and shop drawings.

This study would control project time and expenses for tasks on the critical path that were solely concerned with structural work. Critical path analysis was performed using Primavera P6 by entering project activity data into the computer to determine the project's critical path. Once the critical route was established, the project's duration and costs were examined using the Time-Cost Trade-Off (TCTO) method. Crash length, crash cost, and cost slope were all calculated as part of the TCTO duration and cost analysis. 5. The following are the procedures for using Primavera P6 itself:

a. Create a project file.
b. Set up a work calendar.
c. Set the currency used.
d.Input data on workers, materials, and tools.

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e.Input data on work items performed.
f. Gant chart of work.
g.Cost budget data in Primavera 6.
h. Running the Primavera 6 program.

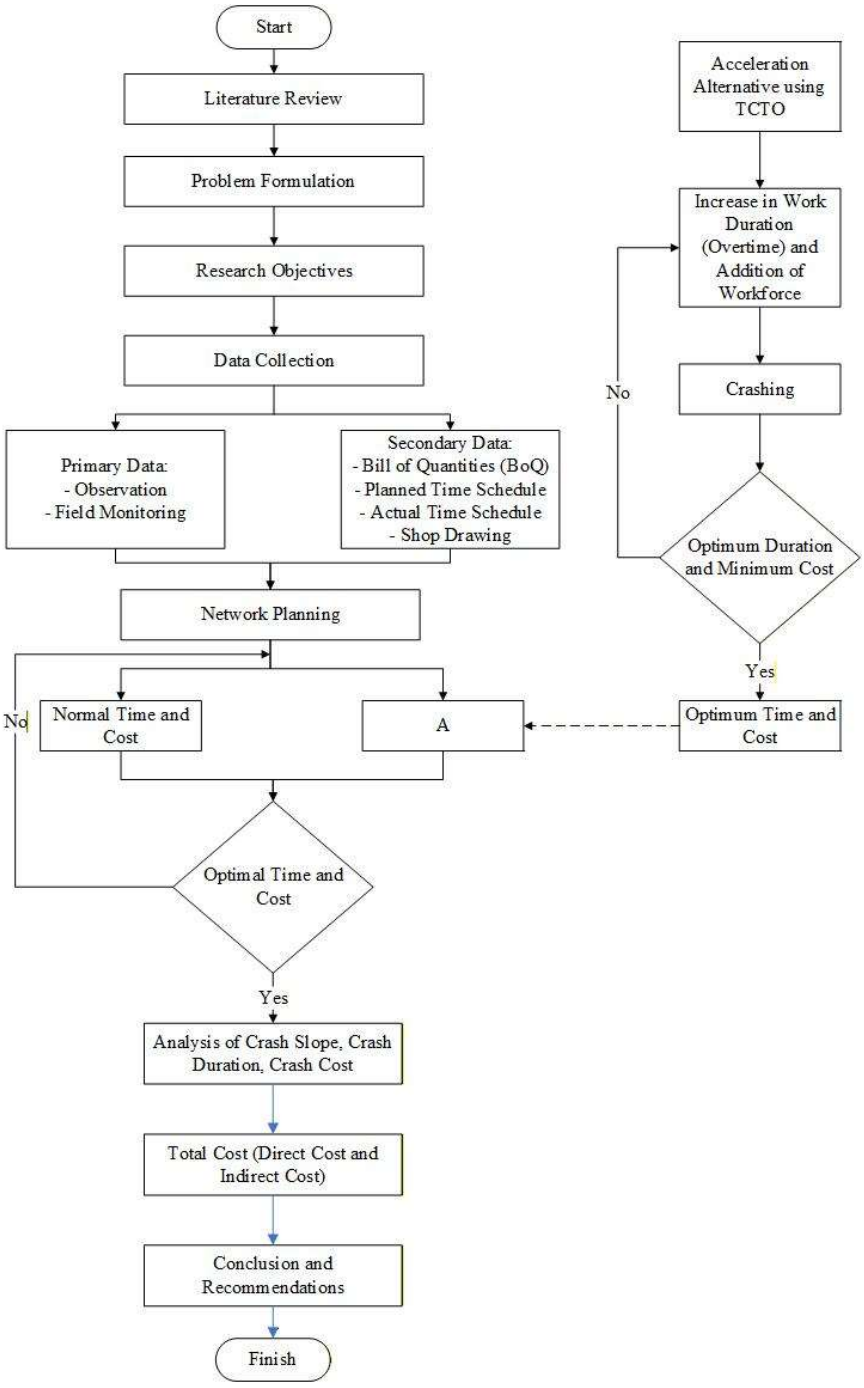

Figure 1. Research Flow Chart

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3. Result and Discussion

Initial research produced a critical path, a sequence of links between critical activities, where each activity takes the longest time from the beginning of the network to the end [17]. Sumobito Community Health Center Building Rehabilitation Project with implementation contract number 027/1609-PPK/415.17/2021 and PT. Delima Kreasi Nusa, as the implementing contractor, was planned to be carried out over 2 floors, with a total cost of IDR 4,062,155,357.13 and an implementation time of 150 calendar days. Scheduling or rescheduling using Primavera produced the same duration as the original scheduling, for IDR 4,062,155,357.13. The critical path in project scheduling was also obtained as follows:

Table 1. Critical Path in Project Scheduling with Primavera Project Planner P6

Code	Work Item	Duration (Days)
A1040	Tree felling (Front of Official Residence and Rear Parking)	1
A1130	Front Yard Landfill h. 24 cm	2
A1140	Installation of an Anstamping Blank Stone	3
A1150	Installation of River Stone Foundations 1 pc: 6 psr	3
A1650	K-250 Concrete Stair Plate	1
A1870	Drainage Concrete Rebate h. 5 cm	1
A2150	Installation of Gypsum Ceiling List 12 cm	1
A2200	Waterproofing Front Porch Concrete Roof	1
A2210	Waterproofing Concrete Gutters	1
A2290	Installation of “Broco Galleo” Double Switch	2
A2380	Removal of Electric Meters and Panel Boxes	2
A2430	Installation of 5 mm PVDF Aluminum Composite Panel (ACP).	1
A2520	Installation of Motif Ceramic Walls 30x60 cm (Bathroom)	1
A2560	Jamb Thread	1
A2640	Roof Gutter Plate h.10 cm K-250	2
A2680	Kalsi Plank 2/40 cm	2
A2720	Installation of Gypsum Board Ceiling List 12 cm	1
A2770	Kalsi Plank Painting	1
A2900	Installation of Sub. panel 2nd Floor (SDP 2)	2
A3010	Installation of Stainless Floor Drain	1
A3040	Installation of P5 Aluminum Doors	1
A3110	Installation of J 16 Aluminum Window	1
A3140	Alphabetical Name of Community Health Center & Counter "Acrylic"	1
A3150	Foundation Soil Excavation (Official Residence)	2
A3220	Landfill under the room floor h. 60 cm	1
A3240	Installation of River Stone Foundation 1 pc: 6 psr (Official Residence)	1
A3260	Installation of stone foundation 1 pc: 6 psr (Fence)	1
A3480	Jamb Thread	1
A3570	Table Plate h.8 cm K-250	1
A3670	Installation of Stainless Floor Drain/Afur	1
A3730	Installation of Boven BV 1 Aluminum	1
A3770	Installation of Gypsum Ceiling List 12 cm	1
A3800	Standard Ridge Roof Top 100 x 50 cm x 0.30 cm "Onduline Tile"	1
A3870	Waterproofing Front Porch Concrete Roof	1
A3940	Installation of 900 Watt Electric Power	2

Source: Primavera Project Planner P6 Output, 2022

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From the critical path in project scheduling with Primavera presented in Table 1, the S curve for Primavera was generated, as shown in Figure 2.

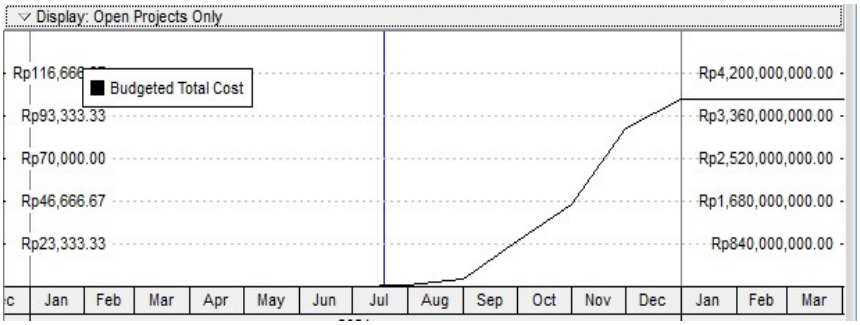

Figure 2. S curve in Primavera
Source: Primavera Project Planner P6 Output, 2022

Then, proceed to look for acceleration using the crashing method in Primavera P6. The work that would be carried out by crashing included:

Table 2. Work to be Accelerated

Code	Work Item	Duration (Days)
A1140	Installation of an Anstamping Blank Stone	3
A2680	Kalsi Plank	2
A1150	Installation of River Stone Foundations 1 pc: 6 psr	3
A2520	Installation of Motif Ceramic Walls 30x60 cm (Bathroom)	1
A2900	Installation of Sub. panel 2nd Floor (SDP 2)	2

Source: Primavera Project Planner P6 Output, 2022

The analysis continued with an acceleration simulation with additional working hours. The first option was to expedite the process by adding overtime, or extra working hours, to the crucial path. Time and cost results would be effective and efficient if the Time Cost Trade-off were accelerated. The first task was to determine how long the crash lasted. Eight hours of regular working time were followed by the retention of extra working hours (overtime). With four workers and an eight-hour regular workday, the crash length with three hours of overtime production was achieved, as shown in Table 3 below:

Table 3. Crash Duration with 3 Hours Overtime Productivity

Work Item	Normal 3 hours (m^3/person)	Overtime 3 hours (m^3/person)	Acceleration Duration (Day)
Installation of Anstamping Blank Stone	9.39	7.861	5
Kalsi Plank	17.906	14.991	5
Installation of River Stone Foundations 1 pc: 6 psr	20.299	16.994	5
Installation of wall ceramic 30x60 cm (Bathroom)	2.363	1.978	5
Installation of Sub. panel 2nd Floor (SDP 2)	0.188	0.157	5

Source: Primavera Project Planner P6 Output, 2022

Next, calculate the acceleration/crash costs. According to the Republic of Indonesia Minister of Manpower and Transmigration Decree No. KEP. 102/MEN/VI/2004, a worker's pay is paid 1.5 times

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their regular hourly wage for the first extra hour of work and twice their regular hourly wage for each additional hour. This calculation uses an additional 3 working hours for normal work. Based on these references, the acceleration costs obtained from 3 hours of overtime productivity are:

Table 4. Acceleration Costs with Additional Working Hours

Work Item	Normal Cost	Crash Cost
Installation of an Anstamping Blank Stone	IDR 28,404,740.11	IDR 27,166,220.24
Kalsi Plank	IDR 10,272,409.75	IDR 6,400,029,768
Installation of River Stone Foundations 1 pc: 6 psr	IDR 150,115,759.97	IDR 96,756,469.28
Installation of Ceramic Wall 30x60 cm (Bathroom)	IDR 3,593,252.38	IDR 7,197,041.75
Installation of Sub. panel 2nd Floor (SDP 2)	IDR 8,455,299.60	IDR 11,238,432.98

Source: Primavera Project Planner P6 Output, 2022

From all the calculations above, an S curve was obtained from the acceleration simulation with additional working hours on the Primavera, which can be studied in Figure 3 below:

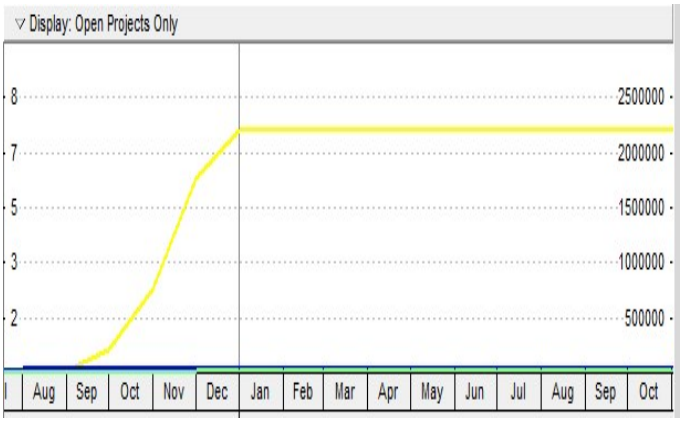

Figure 3. S Curve of Acceleration Costs with Additional Working Hours at Primavera
Source: Primavera Project Planner P6 Output, 2022

The analysis continued with the second alternative, namely, acceleration simulation with additional labor. The second alternative is to accelerate work by adding additional labor to the critical path. By accelerating the Time Cost Trade-off, effective and efficient cost and time results would be obtained. The calculation results obtained for 5 works will be explained as follows:

a) Installation of an Anstamping Blank Stone
In working on the installation of an Anstamping blank stone using acceleration simulation with additional labor, it was determined that the additional wage cost for workers would be IDR 60,843.75 per person. With costs for the foreman IDR 102,400.00, head craftsman IDR 102,400.00, craftsman IDR 63,868.75, and workers IDR. 60,843.75, it was found that the total additional labor costs were = Σ total material costs + (Additional labor costs x acceleration duration) = IDR 14,472,957.60 + (562,700 x 39) = IDR 36,418,257.60. As for Overhead & Profit 10% = 36,418,257.60 + (36,418,257.60 x 0.1) = IDR 40,060,083.36.

b) Kalsi Plank
In working on the kalsi plank using acceleration simulation with additional labor, an additional 1 person was added for the chief craftsman, 1 for the craftsman, and 1 for the worker. With costs for the foreman IDR 102,400.00, head craftsman IDR 97,500.00, craftsman IDR 63,868.75, and workers IDR. 60,843.75, it was found that the total additional labor costs were = Σ total material

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costs + (Additional labor costs x acceleration duration) = IDR 1,099,621.38 + (562,700 x 18) = IDR 11,228,221.38. As for Overhead & Profit 10% = 11,228,221.38 + (11,228,221.38 x 0.1) = IDR 12,351,043.52.

c) Installation of River Stone Foundation 1 pc: 6 psr
In working on the installation of a river stone foundation, 1 pc: 6 psr using acceleration simulation with additional labor, 1 additional craftsman, and 1 worker were obtained. With costs for the foreman IDR 102,400.00, head craftsman IDR 97,500.00, craftsman IDR 63,868.75, and workers IDR. 26,550.00, it was found that the total additional labor costs were = Σ total material costs + (Additional labor costs x acceleration duration) = IDR 77,624,826.62 + (651,200 x 32) = IDR 98,463,226.62. As for Overhead & Profit 10% = 98,463,226.62 + (98,463,226.62 x 0.1) = IDR 108,309,549.28.

d) Installation of Motif Ceramic Walls 30x60 cm (Bathroom Walls)
During the installation of a motif ceramic wall (30x60 cm) for a bathroom using accelerated simulation, it was found that no additional labor was required. With costs for the foreman IDR 102,400.00, the head craftsman IDR 97,500.00, the craftsman IDR 92,900.00, and the workers IDR 88,500.00, the total labor cost was found to be the same as the normal cost, namely IDR 3,593,252.38.

e) Installation of Sub. panel 2nd Floor (SDP 2)
During the installation of sub-panel 2nd Floor (SDP 2) using acceleration simulation, it was found that no additional labor was required. With costs for the foreman IDR 102,400.00, the head craftsman IDR 97,500.00, the craftsman IDR 92,900.00, and the workers IDR 88,500.00, it was found that the total cost for the same labor (crash) for installing the sub panels on the 2nd floor was the normal cost, namely IDR 8,455,299.60.

Using cost calculations and work duration in the same way to analyze additional labor, which results in acceleration of work on the critical path, can be studied in Table 5 below:

Table 5. Cost and Duration of Work with Additional Labor

Job Description	Cost (IDR)		Duration	
	Normal	Crash	Normal	Crash
Installation of an Anstamping Blank Stone	28,404,740.11	40.060.083,36	42	39
Kalsi Plank	10,272,409.75	12.351.043,52	21	18
Installation of River Stone Foundations 1 pc: 6 psr	150.115.759,97	108.309.549,28	35	32
Installation of Motif Ceramic Walls 30x60 cm (Bathroom Walls)	3,593,252.38	3,593,252.38	21	18
Installation of Sub. panel 2nd Floor (SDP 2)	8,455,299.60	8,455,299.60	14	11

Source: Primavera Project Planner P6 Output, 2022

From the results of the acceleration simulation analysis with additional labor using Primavera Project Planner P6 on jobs that were on the critical path, the S-curve of acceleration costs with additional labor was also obtained, which is presented in graphical form in Figure 4 as follows:

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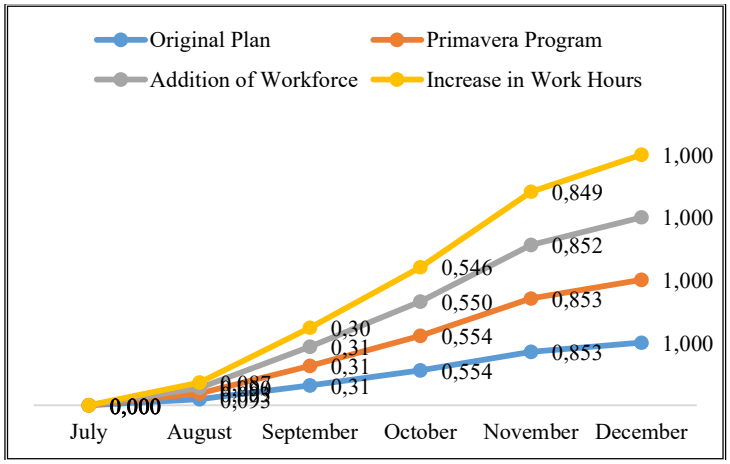

Figure 4. S Curve of Acceleration Costs with Additional Workers at Primavera
Source: Primavera Project Planner P6 Output, 2022

From the results of the S curve of the original plan, the S curve using Primavera Project Planner P6, and the S curve in two alternative simulations, namely the acceleration cost simulation with added working hours and the acceleration cost simulation with the added number of workers, the comparison results can be seen which are presented in the Graphic figure 5 where obtained results showed that the planned work progress was more sloping on the S curve with increased working hours. Thus, the most cost-effective and time-efficient simulations were those that used acceleration and extra working hours.

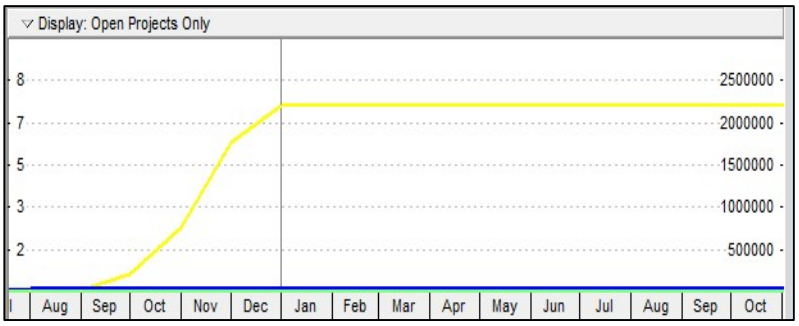

Figure 5. Comparison of S Curves
Source: Data Processing, 2022

The recapitulation of comparative results from research conducted using Primavera P6 for additional working hours and labor in the Sumobito Community Health Center Building Rehabilitation Project, Jombang Regency, is presented in Table 6 as follows:

Table 6. Comparative Recapitulation

Job Description	Duration	Cost (IDR)
Original Project	150	4,062,155,357.13
Using primavera	150	4,062,155,357.13
Acceleration by Additional Working Hours	135	4,004,863,761.46
Acceleration by Adding Workers	135	4,031,275,898.99

Source: Data Processing, 2022

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Based on Table 6 above, the conclusion is that it was more effective to use acceleration alternatives with additional working hours for the Sumobito Community Health Center Building Rehabilitation Project in Jombang Regency, as the duration and costs obtained did not differ much from the initial costs. From the acceleration simulation option with additional labor and working time (overtime hours), the optimal cost and time comparison for this project is as follows:

Table 7. Comparison of Time and Non-VAT Costs

Job Description	Normal Cost (IDR)	Normal time (day)	Additional Overtime Hours (3 hours)		Additional Labor	
			Cost (IDR)	Time (day)	Cost (IDR)	Time (day)
Installation of an Anstamping Blank Stone	28,404,741.11	42.00	27,166,220.24	39.00	40,060,083.36	39.00
Kalsi plank	10,272,409.75	21.00	6,400,029.77	18.00	12,351,043.52	18.00
Installation of River Stone Foundation 1pc: 6psr	150,115,759.97	35.00	96,756,469.28	32.00	108,309,549.28	32.00
Installation of Wall Ceramic 30x60 cm	3,593,252.38	21.00	7,197,041.75	18.00	3,593,252.38	18.00
Installation of Subpanel 2nd Floor (SDP 2)	8,455,299.60	14.00	11,238,432.98	11.00	8,455,299.60	11.00
Amount	200,841,462.81	133.00	148,758,194.02	118.00	172,769,228.14	118.00
Deviation			**52,083,268.79**	**15.00**	**28,072,234.67**	**15.00**

Source: Data Processing, 2022

Comparison of optimal non-VAT costs with time on normal projects, crashing with additional working hours, and labor can be depicted in the graph in Figure 6 as follows:

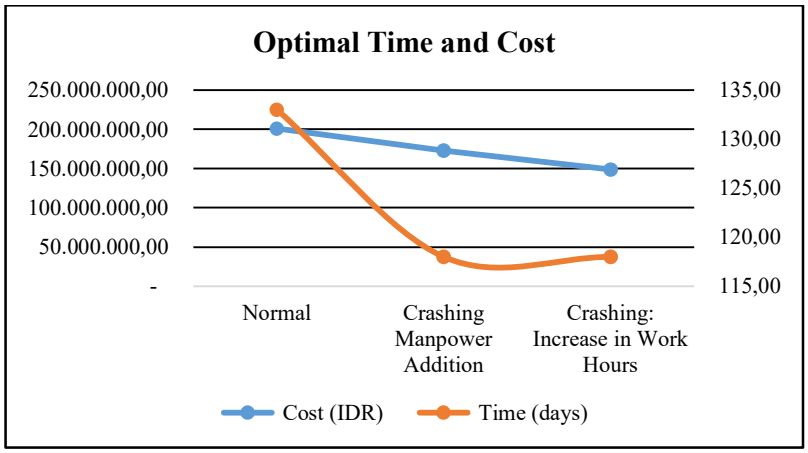

Figure 6. Graph of Optimal Non-VAT Time and Costs
Source: Data Processing, 2022

Based on the table and figure above, it can be concluded that optimal time and costs were achieved in Crashing by adding overtime hours, with a time difference of 15 days and costs of IDR 52,083,268.79 relative to normal time and costs. Overall completion time is an important factor that influences total project costs, and the longer it takes, the more costs are incurred. The term "reducing

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the duration of project completion" refers to efforts to finish the project ahead of schedule [18]. Proper planning and scheduling are necessary to minimize the possibility of project delays. To accelerate project completion, effective scheduling is also needed, given the importance of time and cost and their close interconnection. Primavera Project Planner 6.0 software, when used in conjunction with the Time Cost Trade-Off approach, can assist in project completion planning with accurate, thorough, and detailed scheduling.

In addition to using Primavera 6, other researchers using the Microsoft Project program obtained activities included in the critical path, among others: Demolition of the existing compressor and accessory; demolition of the existing piping and structure; manual excavation and foundation modification; excavation for rerouting cable power; installation of formwork; pouring of the concrete foundation and drying time; installation of the chokeblock; grouting and drying time; installation of the compressor, silencer, after cooler and air filter; installation of the anchor bolt; installation of the base plate and motor plant air compressor; fabrication piping and installation of piping. According to the analysis and computation results, the typical labor cost for 70 days is IDR 332,119,200. After that, acceleration is implemented to achieve an ideal time of adding 3 working hours over 59 days, for IDR 413,932,210, with 11 days of savings and a difference of Rp 81,813,110 from regular costs [4].

4. Conclusions

The costs incurred due to the accelerated duration totaled IDR 4,004,863,761.46, or IDR 57,291,595.67, less than the original costs with VAT. The time obtained due to the accelerated duration was 15 days faster than the original calendar duration of 135 calendar days. The optimal time and minimum cost obtained in Crashing with additional overtime hours were 15 days and IDR 52,083,268.79, respectively, compared with the normal time and costs. From this conclusion, it is recommended that you pay special attention to the critical path, namely the implementation of work, so that it can be completed on time, because if it is late, it will affect everything. When using the Primavera P6 program for project management, it is not enough to have operational knowledge; an understanding of the on-site construction management process is also required. To obtain accurate results, inputting predecessors, successors, resources, and expenses must be done in accordance with Primavera P6 rules. To achieve optimal duration, the network (FS, SS, SF, FF) or jobs available in the Primavera Project Planner P6 software must be more thorough.

Some suggestions for further research related to this research include optimizing ongoing projects so the analysis results can be conveyed to the project implementer. In planning a project's schedule, the TCTO method can be used to optimize scheduling speculation based on existing scheduling.

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References

[1] P. Olivia and V. H. Puspasari, "Analisa Percepatan Waktu Proyek Menggunakan Metode Crashing (Studi Kasus : Peningkatan Jalan Pelantaran – Parenggean – Tumbang Sangai)," *J. Teor. dan Terap. Bid. Keteknikan*, vol. 3, no. 1, pp. 41–52, 2019.

[2] L. V. Pahlevi, R. Sari, and H. Ahmad, "ANALISIS PENERAPAN PSAK 34 DALAM PENGAKUAN PENDAPATAN PERUSAHAAN JASA KONTRUKSI PADA PT ARTERI CIPTA RENCANA," *Invoice J. Ilmu Akunt.*, vol. 3, no. 3, 2021.

[3] J. Angelica, I. A. Puspita, and E. B. Setyawan, "Perancangan Percepatan Waktu Proyek Konstruksi dengan Perbandingan Menggunakan Metode Time Cost Trade Off pada Proyek Pembangunan di PT XYZ," *e-Proceeding Eng.*, vol. 7, no. 02, pp. 6023–6029, 2020.

[4] A. B. Sulistyo, A. Kusdianto, and S. M. Wirawati, "Analisis Manajemen Proyek dengan Sistem Umbrella Contract Menggunakan Metode Time Cost Trade Off (Studi Kasus: PT Jaya

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Inti Teklindo)," *J. PASTI (Penelitian dan Apl. Sist. dan Tek. Ind.*, vol. 17, no. 1, p. 43, 2023, doi: 10.22441/pasti.2023.v17i1.005.

[5] I. Hendriyani, R. Pratiwi, and N. Qadri, "Optimasi Waktu dan Biaya pada Pelaksanaan Proyek Peningkatan Jalan Bina Bakti Kelurahan Gunung Seteleng Kabupaten Penajam Paser Utara dengan Metode Time Cost Trade Off (TCTO)," *J. Ilm. Tek. Sipil TRANSUKMA*, vol. 3, no. 1, pp. 65–76, 2020, doi: 10.36277/transukma.v3i1.72.

[6] D. Laras, "Analisis Percepatan Waktu dan Biaya dengan Metode Crashing pada Proyek Pembangunan Breakwater Pangandaran," *J. CIVeng*, vol. 2, no. 2, pp. 87–94, 2021.

[7] A. Azhari, "ANALISIS PENGENDALIAN BIAYA PROYEK DI PT. PUTRA GEMILANG NIKOM," vol. Vol.3 No.1, pp. 27–40, 2019.

[8] D. Fardila and N. R. Adawyah, "Optimasi Biaya dan Waktu Proyek Konstruksi dengan Lembur dan Penambahan Tenaga Kerja," *INERSIA lNformasi dan Ekspose Has. Ris. Tek. SIpil dan Arsit.*, vol. 17, no. 1, pp. 35–46, 2021, doi: 10.21831/inersia.v17i1.39499.

[9] M. Fazri, M. Widiastuti, and M. Jamal, "JURNAL TEKNOLOGI SIPIL Jurnal Ilmu Pengetahuan dan teknologi sipil."

[10] W. A. Putri, I. Irwan, and M. Ardan, "Analisis Sistem Informasi Penjadwalan Waktu dan Pengendalian Proyek Gedung Perkantoran dan Gudang Suzuya," *J. Civ. Eng. Build. Transp.*, vol. 5, no. 1, pp. 37–45, 2021, doi: 10.31289/jcebt.v5i1.5070.

[11] D. N. Anggraeni, W. Meriana, and S. Nugroho, "OPTIMASI WAKTU DAN BIAYACRASHING DENGAN MENGGUNAKAN METODE TIME COST TRADE OFF," 2019.

[12] Y. Azzahra, L. Lusiana, R. Rafie, S. Syahrudin, and S. M. Nuh, "Time Cost Trade Off Analysis on Project Acceleration With Additional Working Hours (Overtime) (Case Study: Building Rehabilitation Project on Dekranasda Hall of West Kalimantan)," *J. Tek. Sipil*, vol. 23, no. 4, p. 564, 2024, doi: 10.26418/jts.v23i4.71535.

[13] C. Angelia, P. I. Mulyanto, and D. Chrismianto, "Aplikasi Metode Time Cost Trade Off Akibat Keterlambatan Bagian Mesin Pada Proyek Pembangunan Mooring Boat Milik PT. Pertamina Trans Kontinental," *Tek. Perkapalan*, vol. 9, no. 3, pp. 283–2, 2021.

[14] E. A. Budianto and A. E. Husin, "Analisis Optimasi Waktu Dan Biaya Dengan Metode Time Cost Trade Off Pada Proyek Gudang Amunisi.," *J. Apl. Tek. Sipil*, vol. 19, no. 3, p. 305, 2021, doi: 10.12962/j2579-891x.v19i3.9146.

[15] S. Setiono, S. Suryoto, and D. Q. Supriyor, "Analisis Optimasi Biaya dan Waktu Proyek dengan Metode Time Cost Trade Off Menggunakan Aplikasi Primavera P6 (Studi Kasus Proyek Penataan Koridor Jl. Ir. Juanda, Surakarta)," *Matriks Tek. Sipil*, vol. 10, no. 2, p. 90, 2022, doi: 10.20961/mateksi.v10i2.56376.

[16] A. L. Setyabudhi and D. Sasmito, "Perancangan Jadwal Pembuatan Wellhead Dengan Menggunakan Cpm Pada Software Primavera," *J. Ind. Kreat.*, vol. 4, no. 01, pp. 1–6, 2020, doi: 10.36352/jik.v4i01.49.

[17] N. E. Vebiola and J. P. H. Waskito, "Analisis Optimasi Waktu dan Biaya dengan Metode Time Cost Trade Off (Studi Kasus : Proyek Pembangunan Basement Kawasan Balai Pemuda)," *J. Rekayasa dan Manaj. Konstr.*, vol. 8, no. 2, pp. 113–120, 2020.

[18] A. B. Sulistyo and M. Al Fikri, "Analisis Optimalisasi Waktu Dan Biaya Proyek Konstruksi Menggunakan Metode Time Cost Trade Off (Studi Kasus: Proyek Pembangunan Jalan Gorda-Bandung)," *J. InTent*, vol. 4, no. 1, pp. 25–40, 2021.