

# Implement a Strategy to Reduce Time While Paying Attention to Costs Through Crashing

Rehab Raheem Kadhim <sup>1</sup>, Mushtak A.K. Shiker <sup>2</sup>

<sup>1</sup> [rehaabr.alkhafaje@uokufa.edu.iq](mailto:rehaabr.alkhafaje@uokufa.edu.iq) <sup>2</sup> [mmttmmhh@yahoo.com](mailto:mmttmmhh@yahoo.com) ,  
[pure.mushtaq@uobabylon.edu.iq](mailto:pure.mushtaq@uobabylon.edu.iq)

<sup>1,2</sup> Department of Mathematics, College of Education for Pure Sciences, University of Babylon, Hilla, Iraq.

<sup>2</sup> Corresponding Author

## Abstract

Project managers face various obstacles when implementing projects, which causes delays that affect the duration of implementation and the costs incurred. The absence of planning and ineffective control are among the most important reasons that cause delays. Therefore, it is necessary to accelerate and improve what can be done to overcome the cost and time required. To complete the project. As well as effective management of resources. Reducing the cost of building a residential complex through Crashing involves accelerating project activities to shorten the project duration. Crashing is a project management technique where extra resources are added to critical path activities to complete them faster, reducing overall project time. However, this often comes with increased costs. The goal is to find the optimal balance where the increase in cost is justified by the savings from completing the project earlier.

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## INTRODUCTION

Construction projects pose a unique challenge for project managers. The reason behind this is the factors contributing to its unpredictability [1, 2]. Project management helps us make resources available to managers so that they can be appropriately applied to the construction project. Resources used in development projects include labor, equipment, materials, methods, and funds [3, 4]. We note that one of the most critical problems project managers face is the difficulty of delivering on time and the costs incurred as time increases, as clients want to benefit from projects as quickly as possible and at reduced costs [5, 6].

Therefore, in this paper, we discussed the applications of collision in reducing the costs of constructing residential complexes while providing theoretical frameworks and practical examples. The primary goal is to develop a comprehensive strategy to reduce the time while taking care of the costs allocated to the project by applying collision, which should come first. Identify critical activities in the project schedule that are critical and have the most significant impact on the overall project duration.

We evaluated the cost-benefit analysis of downtime and the cost implications of implementing downtime on these critical activities. We assessed whether the reduction in project duration justifies the additional expenditure. Thus, a detailed plan can be formulated to implement project schedule breakdowns, including resource allocation, schedule adjustments, and monitoring mechanisms. We apply the proposed demolition strategy to a residential complex construction project case study and analyze the results to ensure its effectiveness.

## II. Literature Review

Previous studies dealt with project planning and achieving objectives using various planning and scheduling techniques [7]. Studies such as those conducted by Al-Rayes and Qandil (2005) [8] have developed improvement models that integrate breakdown with other project management techniques. These models use linear programming and other mathematical methods to determine optimal failure points that minimize costs while achieving the desired project.

Omar M. Elmabrouk (2012) [9] formulated a simplified small project representation and linear programming model. The procedures for solving these problems and the final solution are mentioned and obtained using LINDO software. The model developed presents several limitations and management. Project considerations. It can be used by construction managers in the planning phase of many explorations. Kim et al. (2012) [10], proposed the mixed linear programming model takes into account the potential quality loss cost (PQLC). This occurs in time and cost tradeoff problems for the extreme collapse of activities. Hiravi and Elbegi (2024) [11] emphasized the role of risk management in collapse. Identifying potential risks and developing mitigation strategies is critical to ensuring that faltering efforts do not lead to unintended consequences that could derail the project.

## III. Project Management

Project management is the use of. There must be multiple stages in project implementation [12, 13].

### 1. Identifying critical path activities

The critical path method (CPM) is used to identify activities that directly affect the project completion date [14, 15]. Only activities on the critical path are candidates for disruption because reducing their duration will reduce the overall project time.

### 2. Determining breakdown costs and duration

For each critical path activity, we must determine the average cost and duration, the downtime cost, and the shortest possible downtime [16, 17]. The cost of breakdowns is usually higher due to the additional resources required.

### 3. Calculating cost slope

The cost slope of an activity is calculated as [18, 19]: 
$$\text{Cost Slope} = \frac{\text{Crash Cost} - \text{Normal Cost}}{\text{Normal Duration} - \text{Crash Duration}}$$
 (1)

This represents the cost per unit of time saved by crashing the activity.

### 4. Selecting activities to crash

Start by first crashing activities with the lowest cost slope, as they offer the most time reduction for the least additional cost [20, 21]. Ensure that crashing these activities will still result in a feasible and logical project schedule.

### 5. Updating the Project Schedule

After each crashing step, update the project schedule and reassess the critical path. Repeat the crashing process if necessary until the project meets the desired completion date or until crashing further is no longer cost-effective.

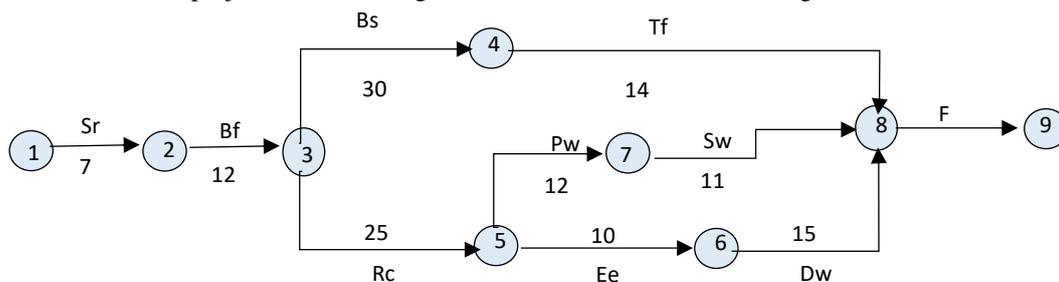
#### IV. Model Implementation

First, we create a schedule of the tasks and work required to develop the project, thus ensuring priorities for the work being carried out can be observed in Table 1.

**Table 1.** Displays cost, normal, and downtime timing.

The Description	The Activities	Normal Time (Nt)	Crash Time (Ct)	Normal Cost (Nc)	Crash Cost (Cc)
Site rehabilitation	Sr	7	5	10000000	11.850000
Building the foundation	Bf	12	10	35000000	37.350000
Building the structure	Bs	30	29	40000000	40700000
Roof and canopy	Rc	25	24	30000000	32750000
Painting walls and floors	Pw	12	11	20000000	21000000
The fence	Tf	14	13	30000000	30800000
Establishment of electricity	Ee	10	9	40000000	42.850000
Sanitation works	Sw	11	10	15000000	15900000
Door and window works	Dw	15	13	40000000	42450000
Finishing	F	5	4	20000000	22550000

Based on Table 1, the project's network diagram is illustrated with the following timeline.



**Figure 1:** The network diagram of the above project

Now, we will find the sequence of dependent activities with the most extended total duration.

Path I Sr- Bf- Bs - Tf - F

Time for this path:  $7+12+30+14+5= 68$  weeks

Path II Sr- Bf- Rc- Pw - Sw - F

Time for this path:  $7+12+25+12+11+5= 72$  weeks

Path III Sr- Bf- Rc- Ee- Dw- F

Time for this path:  $7+12+25+10+15+5=74$  weeks

Note that Path III is the longest after applying the (CPM) and finding all paths. Therefore, the critical path and the critical activations are Sr, Bf, Rc, Ee, Dw, and F. We can calculate the cost of stopping per unit of time for all activities according to Equation 1. The results are shown in Table 2.

**Table 2.** Displays the cost of breakdowns per unit of time for all activities

The Activities	Nt	Ct	Nc	Cc	Nt - Ct	Nc- Cc	per
Sr	7	5	10000000	11.850000	2	1850000	925000
Bf	12	10	35000000	37.350000	2	2350000	1175000
Bs	30	29	40000000	40700000	1	700000	700000
Rc	25	24	30000000	32750000	1	2750000	2750000
Pw	12	11	20000000	21000000	1	1000000	1000000
Tf	14	13	30000000	30800000	1	800000	800000
Ee	10	9	40000000	42.850000	1	2850000	2850000
Sw	11	10	15000000	15900000	1	900000	900000
Dw	15	13	40000000	42450000	2	2450000	1225000
F	5	4	20000000	22550000	1	2550000	2550000

**Table 3.** Displays the activities that have been disabled

Tracks	The least costly activity of the critical path									
	Sr	Sr	Bf	Bf	Dw	Dw	F	Rc	Ee- Sw	
Path I Sr- Bf- Bs - Tf - F =68	67	66	65	64	64	64	63	63	63	
Path II Sr- Bf- Rc- Pw - Sw - F =72	71	70	69	68	68	68	67	66	65	
Path III Sr- Bf- Rc- Ee- Dw- F =74	73	72	71	70	69	68	67	66	65	

## V. Results and Discussion

Analysis of critical paths and crashing processes in Table 3

- Through the first column, the critical path for the three paths can be known, and since the path, Sr-Bf-Rc-Ee-Dw-F is the critical path, the lowest cost of the activities in the critical path is activity Sr, at a cost of 925,000. So it can be speeded up, reducing the time by one week and increasing the cost by 925,000. So, the second column will be the length of the tracks after crashing.
- Through the second column, the critical path after crashing can be determined. The critical path Sr-Bf-Rc-Ee-Dw-F has a duration of 73 weeks. Since the Sr activity has the lowest cost of 925,000, the crashing time can be because the difference between the normal and stop times is 2.
- So, the third column is the length of the paths after the collapse. By repeating the disruption process, we notice in the third column that the critical path is Sr- Bf- Rc- Ee- Dw- F. Since the lowest cost of the critical path is 1,175,000 for activity Bf, the project can be accelerated by one week at a cost of 1,175,000. The fourth column is the length of the paths after the last breakdown. It is clear that the critical path is Sr-Bf-Rc-Ee-Dw-F, and the lowest cost of the critical path is 1,175,000 for activity Bf. The project is accelerated for one week at a cost of 1,175,000.
- Through the fourth column, the critical path after crashing can be determined. The critical path Sr-Bf-Rc-Ee-Dw-F has a duration of 71 weeks. Bf activity has the lowest cost of 1,175,000, and the crashing time can be due to the difference between normal time and downtime is 2. Hence, the time is reduced by one week, and the cost increases by 1,175,000. Therefore, the fifth column will be the length of the paths after crashing.

- The critical path after crushing can be determined through the fifth and sixth columns. It is clear that the critical path Sr-Bf-Rc-Ee-Dw-F has a duration of 70 weeks for the fifth column and 69 for the sixth column. Since the Dw activity has the lowest cost of 1,225,000, the crushing time can be because the difference between the normal time and the downtime is 2. So, it can be broken for two weeks, and the cost can be increased by 1,225,000 each week. Therefore, the sixth column will be the length of the paths after crushing.
- The critical path after crushing can be determined through the fifth and sixth columns. It is clear that the critical path Sr-Bf-Rc-Ee-Dw-F has a duration of 70 weeks for the fifth column and 69 weeks for the sixth column. Dw activity has the lowest cost of 1,225,000, and the breaking time can be because the difference between normal time and downtime is 2. So, it can be broken for two weeks, and the cost can be increased by 1,225,000 each week. Therefore, the sixth column will be the length of the paths after crushing.
- We note that in the seventh column, there are two critical paths, which are Sr- Bf- Rc- Ee- Dw- F and also Sr- Bf- Rc- Pw - Sw - F, and the lowest cost available in the two paths is 2,550,000 for activity F, which is an everyday activity between the two critical paths. Therefore, the time can be reduced by one week at a cost of 2,550,000.
- The eighth column has two critical paths: Sr- Bf- Rc- Ee- Dw- F and Sr- Bf- Rc- Pw - Sw F. Their duration is 67 weeks and at the lowest available cost. In the two paths, it is 2,750,000 for the Rc activity, which is an everyday activity between the two critical paths, so the time can also be reduced by a week at a cost of 2,750,000.
- We note that in the ninth column, Sw and Ee were destroyed, and because the critical paths are Sr- Bf- Rc- Ee- Dw- F and also Sr- Bf- Rc- Pw - Sw - F, the lowest cost available in the two paths is 2,850,000 for activity Ee and 900,000 for activity Sw. The destruction cost is 3,750,000 for both activities. Finally, in the last column, we note that the critical path is Sr- Bf- Rc- Pw - Sw - F and Sr- Bf- Rc- Ee- Dw- F, with a duration of 65 weeks, but all activities are in the path Sr- Bf- Rc- Ee- Dw -F It crashed. So we cannot do any destruction and then stop.

The activities that were disrupted are Sr, Sr, Bf, Bf, Dw, Dw, F, Rc, Ee-Sw, and the project completion time was reduced by nine weeks at a cost of 15,700,000.

The total cost can be calculated according to the equation below [22, 23]:

$$\text{Total cost} = \text{Total regular time costs} + \text{Total acceleration time costs for activities} \quad (2)$$

To find the normal time costs, we collect the normal time costs column in Table (2) with the total costs of 280,000,000. As for the total acceleration time costs for activities, it is 15,700,000, so we get :

$$\text{Total cost} = 280,000,000 + 15,700,000 = 295,700,000 \text{ and within a time of 65 weeks}$$

Strategically breaking down activities with the lowest cost slope reduces the project duration with the most minor cost increase.

## VI. Conclusion

The primary advantage of collapsing is the potential for significant time savings, which can lead to cost reductions in the project. The main conclusions drawn from applying collision techniques in residential complex projects include effective time management downtime, allowing for a more flexible and responsive project schedule. Project managers can ensure that delays are addressed immediately by focusing on critical path activities, thus maintaining project momentum and avoiding long completion times. Although disruption may initially increase costs due to the addition of resources, overall project costs can be reduced by reducing delays and avoiding the high costs associated with long project durations. Timely completion of projects can also

generate revenue faster than selling or renting residential units. Downtime also helps identify potential bottlenecks early in the project, allowing proactive measures to mitigate risks. By anticipating and addressing delays, project managers can prevent issues from escalating that could lead to significant project overruns. The application of demolition techniques in the construction of residential complexes provides a systematic approach to achieving time and cost efficiency. Although it requires careful planning and implementation, the benefits of reduced project timelines and optimized use of resources make it a valuable strategy in modern construction project management. By adopting collapse as standard practice, the construction industry can enhance its ability to deliver high-quality residential complexes on time and within budget, ultimately contributing to sustainable growth and development.

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