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# COMPARISON OF THE CCPM WITH CPM METHODOLOGY FOR CONSTRUCTION OF THE RESIDENTIAL BUILDING

**[1]Nihar M. Pithva, [2]Prof. Jayraj V. Solanki, [3]Prof. Ankit S. Patel**

[1]M. Tech student, [2]Head of PG, [3]PG Co-Ordinator

[1]Construction Engineering and Management,

[1]U.V. Patel College of Engineering, Ganpat University, Kherva, Gujarat, India.

*Abstract:* The construction industry is one of the largest and most complex industries in our economy. It employs millions of people and is responsible for constructing the buildings and infrastructure we depend on daily. In the construction industry, the main problem here is that more than half of construction projects face problems such as cost overruns & time overruns. Traditional project management methods such as the Critical Path Method (CPM) have identified the main disadvantage that prioritizing project tasks over resources. People are developing a new planning method called Critical Chain Project Management in response to the limitations of traditional methods (CCPM). a critical path method is the sequence of project network activities that add up to the longest overall duration, regardless if the longest duration has float or not. This determines the shortest time possible to complete the project. There can be a 'total float' within the critical path. Critical Chain Project Management was developed by Eliyahu. M Gold Ratt. Since its establishment in 1997, it has made great strides in the field of project management. CCPM is a way to plan and manage project uncertainty, prioritize resources to complete project tasks, deliver projects faster, and impact quality compared to traditional CPM methods. For the comparison of CCPM and CPM methodology data collection was done by four sites. Ahead schedules were prepared for four sites by CPM in MS Project software. Then reschedules were prepared by the CCPM cut and paste buffer sizing method. The analysis concludes that, in case study 1 the time duration is reduced by 452 days after applying the CCPM method by cut and paste buffer sizing. Same as in case studies 2,3, and 4 the result of a reduction of days are 366 days, 346 days, and 328 days respectively.

***Index Terms*** **– CCPM, CPM, Construction industry, Buffer, Buffer sizing method**

## I. INTRODUCTION

After the Agriculture industry, the construction industry in India is the 2nd largest industry. Nearly 16% of the country's workforce depends on the construction industry for a living. However, the main problem here is that more than half of construction projects face problems such as cost overruns & overruns that are not being completed on time. The main drawbacks have been identified by traditional project management methods such as the Critical Path Method (CPM) & Program Evaluation & Review Technology (PERT). Traditional methods are focused on project tasks rather than resources. Due to the limitations of traditional methods, people are developing a new planning method called Critical Chain Project Management (CCPM).

- **What is Critical Chain Project Management (CCPM)?**

Critical Chain Project Management was developed by Eliyahu. M Gold Ratt. Since its establishment in 1997, it has made great strides in the field of project management. CCPM is a way to plan and manage project uncertainty, prioritize resources to complete project tasks, deliver projects faster, and impact quality compared to traditional CPM methods. The aim is to achieve this through the process of waste reduction without compromise.

The first step in CCPM is to create an initial schedule & estimated time frame for your project activities. Dependencies between activity (reflected in the project network) & resource availability are taken into account. At this point, CCPM identifies the "critical chain" as a set of activities. These activities lead to the longest path of completing the project after resource balancing. The next step in CCPM planning is to recalculate the project schedule based on the estimated reduced activity period. The following steps are for shortening the duration of CCPM.

1. The estimated activity will be reduced by 50%, & the last 50% duration is used as a buffer.
2. After the 1st step, set feeding buffer which is half the duration of summation of non-critical chain which intersects the critical chain.
3. After the 2nd step, set project buffer which is half the duration of summation of critical chain.

- **Types of Buffers:**

The CCPM method provides the safety time in the form of a buffer. In CCPM, three types of buffers are used: project buffers, feeding buffers, and resource buffers. These buffers serve as a safety net and are strategically placed throughout the project. These buffers protect tasks from statistical discrepancies and act as a cushion against overrunning tasks without affecting the project completion date.

**Project Buffer**: This is inserted after the last task in the critical chain.
**Feeding Buffer**: This buffer is inserted at places where the non-critical tasks feed into the Critical Chain.
**Resource Buffer**: This buffer is placed whenever a particular resource has a job on the critical chain. Resource buffers indicate that those resources are available whenever needed.

## II. OBJECTIVE

- To study the concept of CCPM & CPM.
- To apply CCPM & CPM for the reduction of time (for residential projects).

## III. NEED OF STUDY

Current scenario is that the maximum of the infrastructure initiatives in India does now no longer end on time, within the scope, & inside budget. A great number of Project Managers demonstrate that the normal cost of the project goes up by 25% as of the planned cost as a result of reprehensible planning & scheduling. In the construction sector, there is a lack of Awareness regarding the CCPM method & they are highly focused on the traditional construction method.

## IV. RESEARCH METHODOLOGY

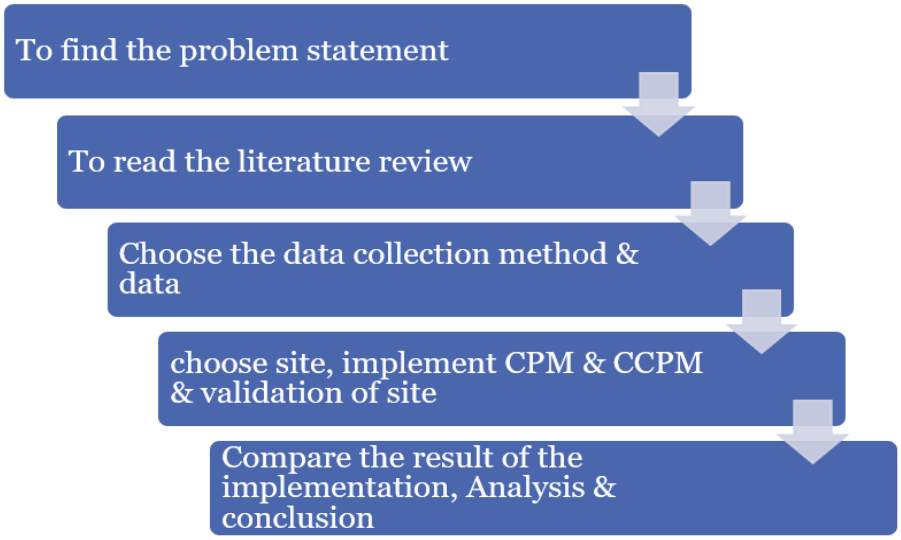


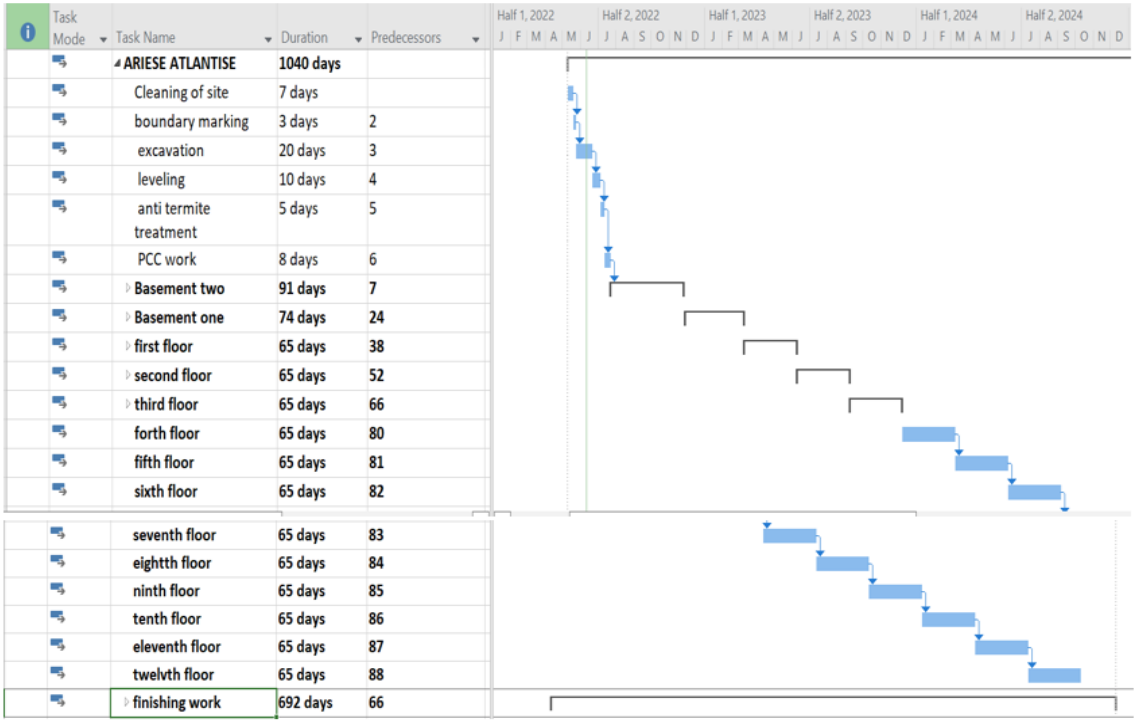

***Figure 1 methodology***

## V. DATA COLLECTION

In my research area, for data collection, I have chosen a qualitative approach. For comparison of CCPM & CPM methodology, I have chosen the case study method. Further, I have taken 4 construction sites of residential buildings. Later I collected primary data & taken approval & validation from the site engineers Who have valuable experience in this field. I have also discussed my research area with them & I have got fruitful clarity in my area of work. Later, I made the schedule of activities in MS project software. Subsequently, I have compared it with the CCPM methodology.
Further pieces of information regarding sites are shown below.

### Case study 1

Here is the basic information regarding the site where I have taken primary data. The site is located in Ahmedabad, Gujarat 382481. The plot area of the site is 14670 Sqm & the construction area is 7122 Sqm. The zone of the site is R1(new west). On this site, there are 5 blocks (A, B, C, D, E, & F.) G+12 with 2 basements. Further, I have prepared a proposed schedule of work in MS project software. Which is shown below.



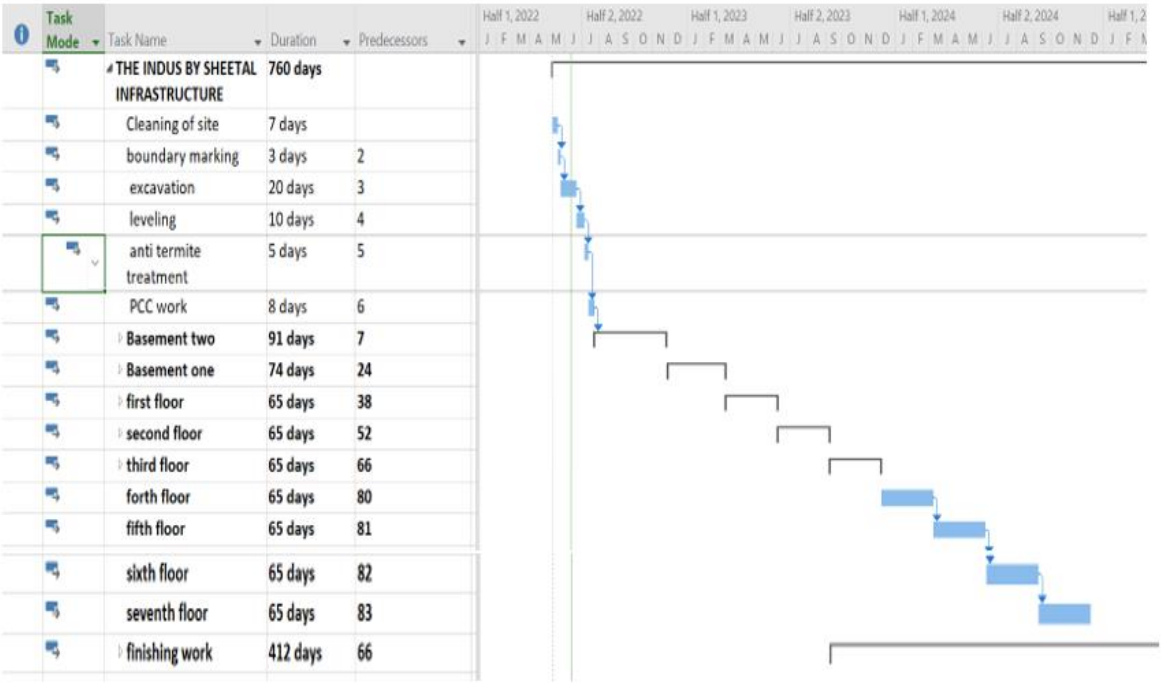
| Task Mode | Task Name | Duration | Predecessors |
|---|---|---|---|
| | ARIESE ATLANTISE | 1040 days | |
| | Cleaning of site | 7 days | |
| | boundary marking | 3 days | 2 |
| | excavation | 20 days | 3 |
| | leveling | 10 days | 4 |
| | anti termite treatment | 5 days | 5 |
| | PCC work | 8 days | 6 |
| | Basement two | 91 days | 7 |
| | Basement one | 74 days | 24 |
| | first floor | 65 days | 38 |
| | second floor | 65 days | 52 |
| | third floor | 65 days | 66 |
| | forth floor | 65 days | 80 |
| | fifth floor | 65 days | 81 |
| | sixth floor | 65 days | 82 |
| | seventh floor | 65 days | 83 |
| | eightth floor | 65 days | 84 |
| | ninth floor | 65 days | 85 |
| | tenth floor | 65 days | 86 |
| | eleventh floor | 65 days | 87 |
| | twelvth floor | 65 days | 88 |
| | finishing work | 692 days | 66 |



*Figure 2 schedule in MS Project*

**Case study 2**

Here is the basic information regarding 2nd site where I have taken primary data. The site is located in Ahmedabad, Gujarat-380054. The plot area of the site is 5170 Sqm & the construction area is 4550 Sqm. On this site, there are 2 blocks (A, & B.) G+7 with 2 basements. The project commencement date is May 2022. Further, I have prepared a proposed schedule of work in MS project software. Which is shown below.



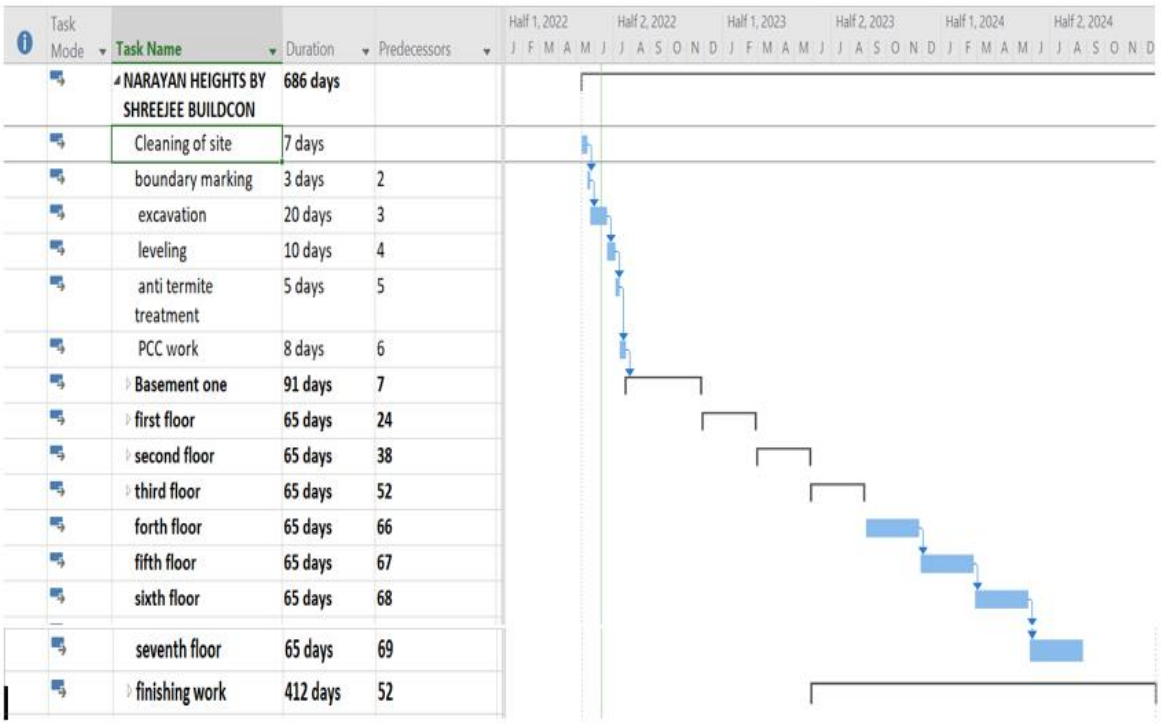
| Task Mode | Task Name | Duration | Predecessors |
|---|---|---|---|
| | THE INDUS BY SHEETAL INFRASTRUCTURE | 760 days | |
| | Cleaning of site | 7 days | |
| | boundary marking | 3 days | 2 |
| | excavation | 20 days | 3 |
| | leveling | 10 days | 4 |
| | anti termite treatment | 5 days | 5 |
| | PCC work | 8 days | 6 |
| | Basement two | 91 days | 7 |
| | Basement one | 74 days | 24 |
| | first floor | 65 days | 38 |
| | second floor | 65 days | 52 |
| | third floor | 65 days | 66 |
| | forth floor | 65 days | 80 |
| | fifth floor | 65 days | 81 |
| | sixth floor | 65 days | 82 |
| | seventh floor | 65 days | 83 |
| | finishing work | 412 days | 66 |



*Figure 3 schedule in MS Project*

**Case study 3**

Here is the basic information regarding 3rd site where I have taken primary data. The site is located in Ahmedabad, Gujarat-380054. The plot area of the site is 5680 Sqm & the construction area is 4250 Sqm. On this site, there are 3 blocks (A, B & C.) G+7 with 1 Basement. The project commencement date is Feb 2023. Additionally, I have prepared a proposed schedule of work in MS project software. Which is shown below.



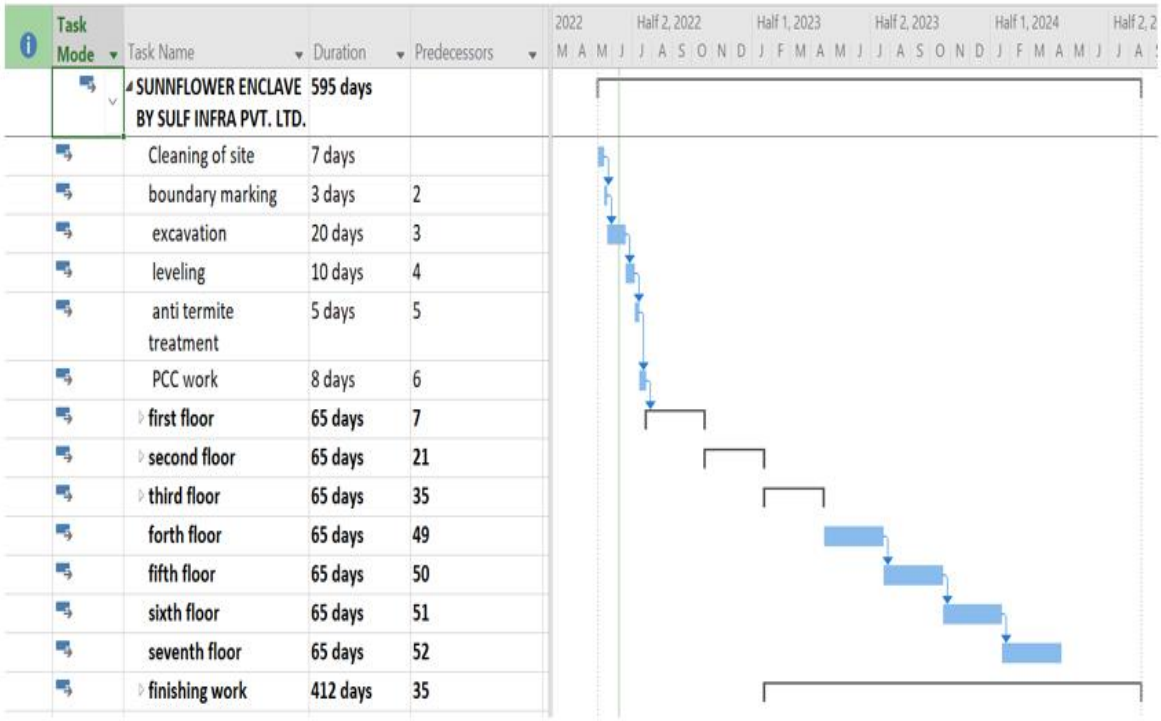
| Task Mode | Task Name | Duration | Predecessors |
|---|---|---|---|
| | NARAYAN HEIGHTS BY SHREEJEE BUILDCON | 686 days | |
| | Cleaning of site | 7 days | |
| | boundary marking | 3 days | 2 |
| | excavation | 20 days | 3 |
| | leveling | 10 days | 4 |
| | anti termite treatment | 5 days | 5 |
| | PCC work | 8 days | 6 |
| | Basement one | 91 days | 7 |
| | first floor | 65 days | 24 |
| | second floor | 65 days | 38 |
| | third floor | 65 days | 52 |
| | forth floor | 65 days | 66 |
| | fifth floor | 65 days | 67 |
| | sixth floor | 65 days | 68 |
| | seventh floor | 65 days | 69 |
| | finishing work | 412 days | 52 |



*Figure 4 Schedule in MS Project*

**Case study 4**

Here is the basic information regarding 4th site where I have taken primary data. The site is in Ahmedabad, Gujarat-380055. The plot area of the site is 5320 Sqm & the construction area is 3498 Sqm. On this site, there are 3 blocks (D, E & F.) G+7. The project commencement date is Dec 2022. Additionally, I have prepared a proposed schedule of work in MS project software Which is shown below.



| Task Mode | Task Name | Duration | Predecessors |
|---|---|---|---|
| | SUNNFLOWER ENCLAVE BY SULF INFRA PVT. LTD. | 595 days | |
| | Cleaning of site | 7 days | |
| | boundary marking | 3 days | 2 |
| | excavation | 20 days | 3 |
| | leveling | 10 days | 4 |
| | anti termite treatment | 5 days | 5 |
| | PCC work | 8 days | 6 |
| | first floor | 65 days | 7 |
| | second floor | 65 days | 21 |
| | third floor | 65 days | 35 |
| | forth floor | 65 days | 49 |
| | fifth floor | 65 days | 50 |
| | sixth floor | 65 days | 51 |
| | seventh floor | 65 days | 52 |
| | finishing work | 412 days | 35 |



*Figure 5 Schedule in MS Project*

## VI. DATA ANALYSIS

The following general steps are followed for the CCPM methodology.
1. aggressively 50%-time estimation was calculated for every activity.
2. Resources are allocated separately to every activity & they must be leveled.
3. After, Resource leveling, relationships between activities are expected to incorporate every task dependency & also the leveled resources' dependencies.
4. Longest path of the activities including both tasks & resources is identified as a critical chain.
5. the whole project is rescheduled for the assurance that the critical chain is still the same for the project.

6. The project buffer was inserted at the end of the critical chain also the feeding buffers are inserted at the end of each non-critical chain to prevent non-critical chains.

**The buffers are calculated by Buffer-sizing methods which is shown below.**

**Buffer sizing methods:**

1. Cut and Paste method
2. Root square error method.
3. Adaptive procedure with resource tightness.
4. Adaptive procedure with density.

**cut & paste method:**

This is the first and most simplified method proposed by Eliyahu M. Goldratt and it has been named later as 50% of the chain method or the "cut and paste method". In this method, the buffer size is considered as half of the longest path in the chain. Although this method is very easy to calculate, it has limitations such as activity with a larger duration will lead to producing a larger buffer which ultimately lacks optimization in the buffer sizing method.
In the cut & paste method, The project buffer is half the length of the critical chain, & the feeding buffer is half the length of the noncritical chain.

**Case study 1**

On this site by CPM methodology, the time duration is **1040 days**.
In the CCPM methodology, there are **452 days** reduced.

Project buffer = 200 days
Feeding buffer 1 = 50 days
Feeding buffer 2 = 40 days

The total duration of the project by the Cut & paste method is **788 Days.**

| Task Mode | Task Name | Duration | Predecessors |
|---|---|---|---|
| | **ARIESE ATLANTISE** | **788 days** | |
| | Cleaning of site | 4 days | |
| | boundary marking | 2 days | 2 |
| | excavation | 12 days | 3 |
| | leveling | 5 days | 4 |
| | anti termite treatment | 3 days | 5 |
| | PCC work | 4 days | 6 |
| | **Basement two** | **50 days** | **7** |
| | **Basement one** | **42 days** | **24** |
| | **first floor** | **35 days** | **38** |
| | **second floor** | **35 days** | **52** |
| | **third floor** | **35 days** | **66** |
| | **forth floor** | **35 days** | **80** |
| | **fifth floor** | **35 days** | **81** |
| | **sixth floor** | **35 days** | **82** |
| | **seventh floor** | **35 days** | **83** |
| | **eighth floor** | **35 days** | **84** |
| | **ninth floor** | **35 days** | **85** |
| | **tenth floor** | **35 days** | **86** |

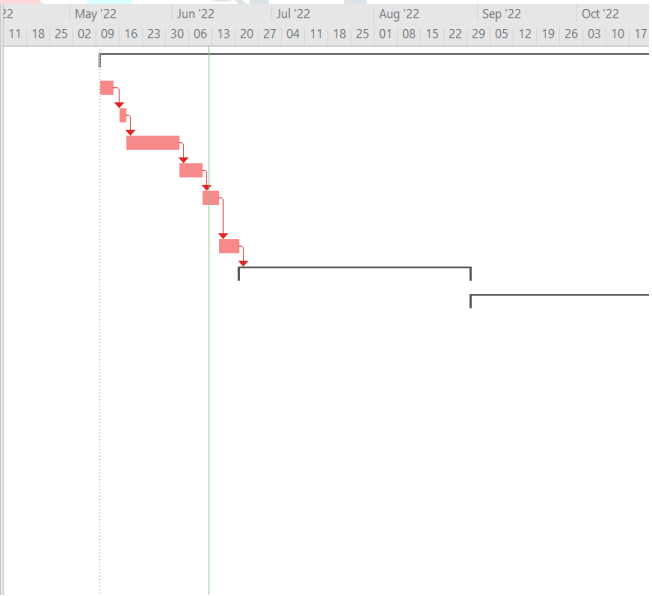


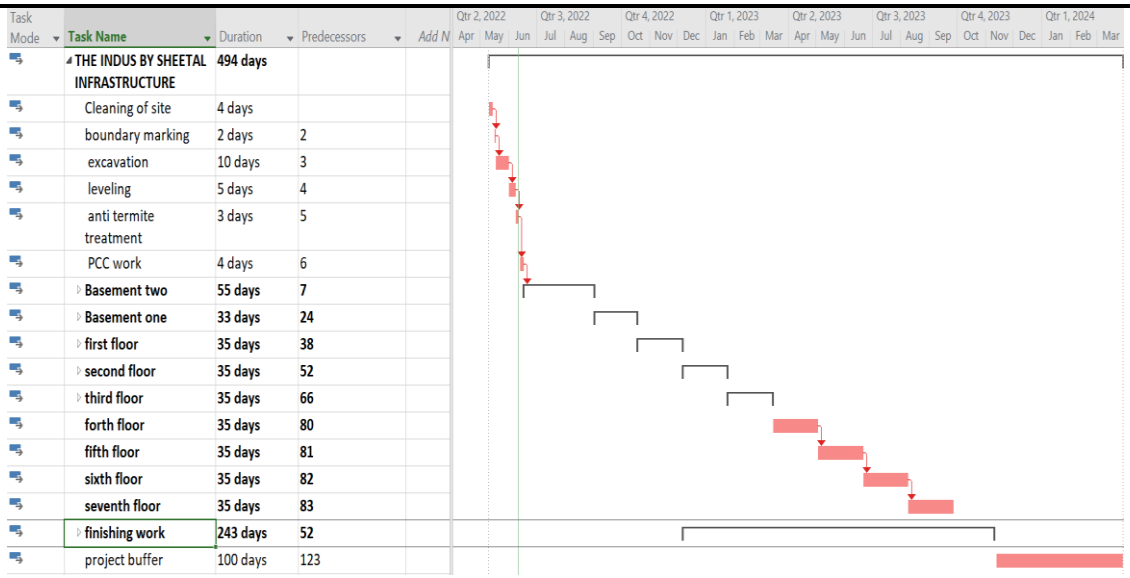

***Figure 6 after applying cut and paste buffer sizing method***

**Case study 2**

On this site by CPM methodology, the time duration is **760 days**.
In the CCPM methodology, there are **366 days** reduced.

Project buffer = 100 days
Feeding buffer 1= 50 days
Feeding buffer 2= 40 days

The total duration of the project by the Cut & paste method is **494 Days.**



| Task Mode | Task Name | Duration | Predecessors |
|---|---|---|---|
| | THE INDUS BY SHEETAL INFRASTRUCTURE | 494 days | |
| | Cleaning of site | 4 days | |
| | boundary marking | 2 days | 2 |
| | excavation | 10 days | 3 |
| | leveling | 5 days | 4 |
| | anti termite treatment | 3 days | 5 |
| | PCC work | 4 days | 6 |
| | Basement two | 55 days | 7 |
| | Basement one | 33 days | 24 |
| | first floor | 35 days | 38 |
| | second floor | 35 days | 52 |
| | third floor | 35 days | 66 |
| | forth floor | 35 days | 80 |
| | fifth floor | 35 days | 81 |
| | sixth floor | 35 days | 82 |
| | seventh floor | 35 days | 83 |
| | finishing work | 243 days | 52 |
| | project buffer | 100 days | 123 |



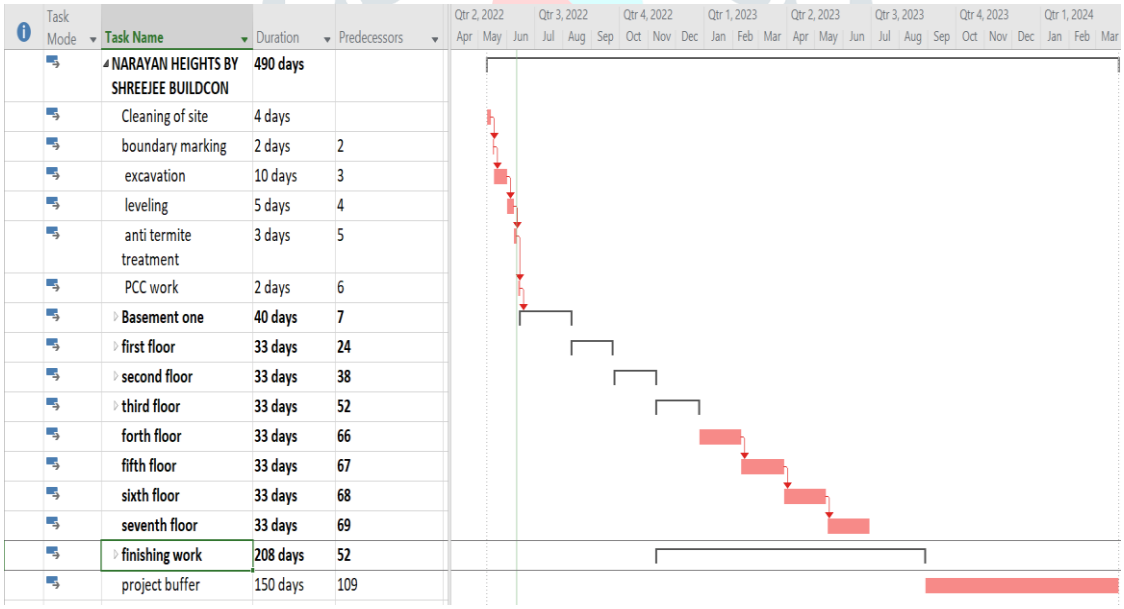
*Figure 7 after applying cut and paste buffer sizing method*

**Case study 3**

On this site by CPM methodology, the time duration is **686 days**.
In the CCPM methodology, there are **346 days** reduced.

Project buffer = 150 days
Feeding buffer 1= 50 days
Feeding buffer 2= 60 days

The total duration of the project by the Cut & paste method is **490 Days.**



| Task Mode | Task Name | Duration | Predecessors |
|---|---|---|---|
| | NARAYAN HEIGHTS BY SHREEJEE BUILDCON | 490 days | |
| | Cleaning of site | 4 days | |
| | boundary marking | 2 days | 2 |
| | excavation | 10 days | 3 |
| | leveling | 5 days | 4 |
| | anti termite treatment | 3 days | 5 |
| | PCC work | 2 days | 6 |
| | Basement one | 40 days | 7 |
| | first floor | 33 days | 24 |
| | second floor | 33 days | 38 |
| | third floor | 33 days | 52 |
| | forth floor | 33 days | 66 |
| | fifth floor | 33 days | 67 |
| | sixth floor | 33 days | 68 |
| | seventh floor | 33 days | 69 |
| | finishing work | 208 days | 52 |
| | project buffer | 150 days | 109 |



*Figure 8 after applying cut and paste buffer sizing method*

**Case study 4**

On this site by CPM methodology, the time duration is **595 days**.
In the CCPM methodology, there are **328 days** reduced.

Project buffer = 130 days
Feeding buffer 1= 30 days
Feeding buffer 2= 25 days

The total duration of the project by the Cut & paste method is **397 Days.**

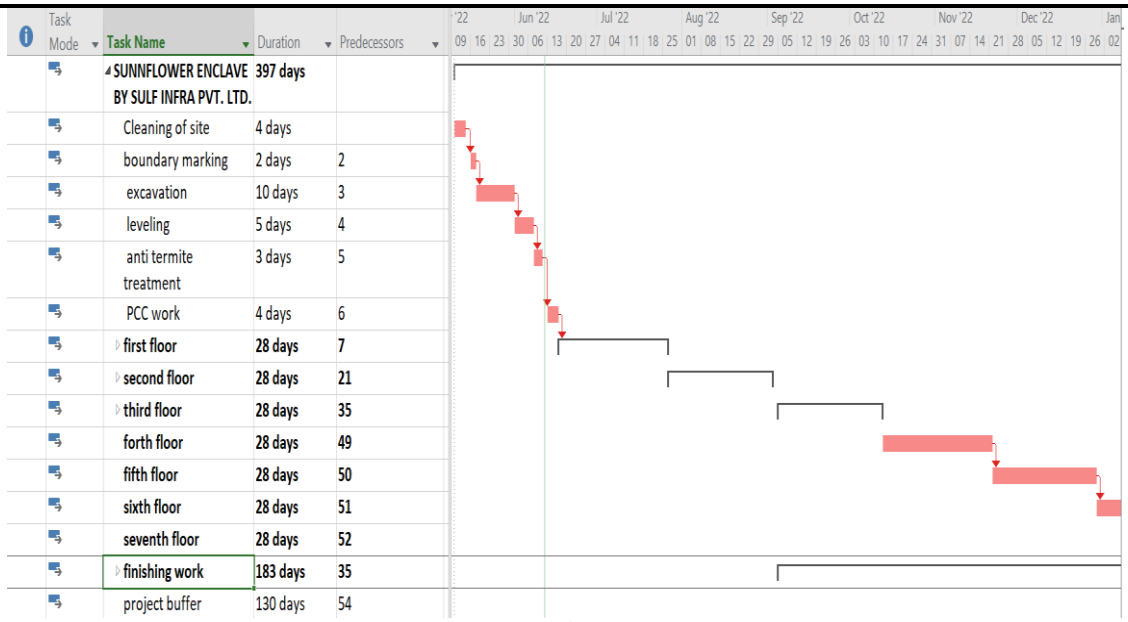



*Figure 9 after applying cut and paste buffer sizing method*

**A comparison of CPM & CCPM methodology is shown in the table below.**

*Table 1 comparison of CPM and CCPM*

| Sr. no | Site name | CPM | CCPM (C&P method) |
|---|---|---|---|
| 1. | Case study 1 | 1040 days | 788 days |
| 2. | Case study 2 | 760 days | 494 days |
| 3. | Case study 3 | 686 days | 490 days |
| 4. | Case study 4 | 595 days | 397 days |

In case study 1 by CPM 1040 days required for schedule whereas, by CCPM (C&P method) 788 days required. Same as in case study 2, case study 3, & case study 4 by CPM 760 days, 686 days, and 595 days required and by CCPM 494 days, 490 days, and 397 days respectively required.

The graph of A comparison of CPM & CCPM methodology is shown in the below

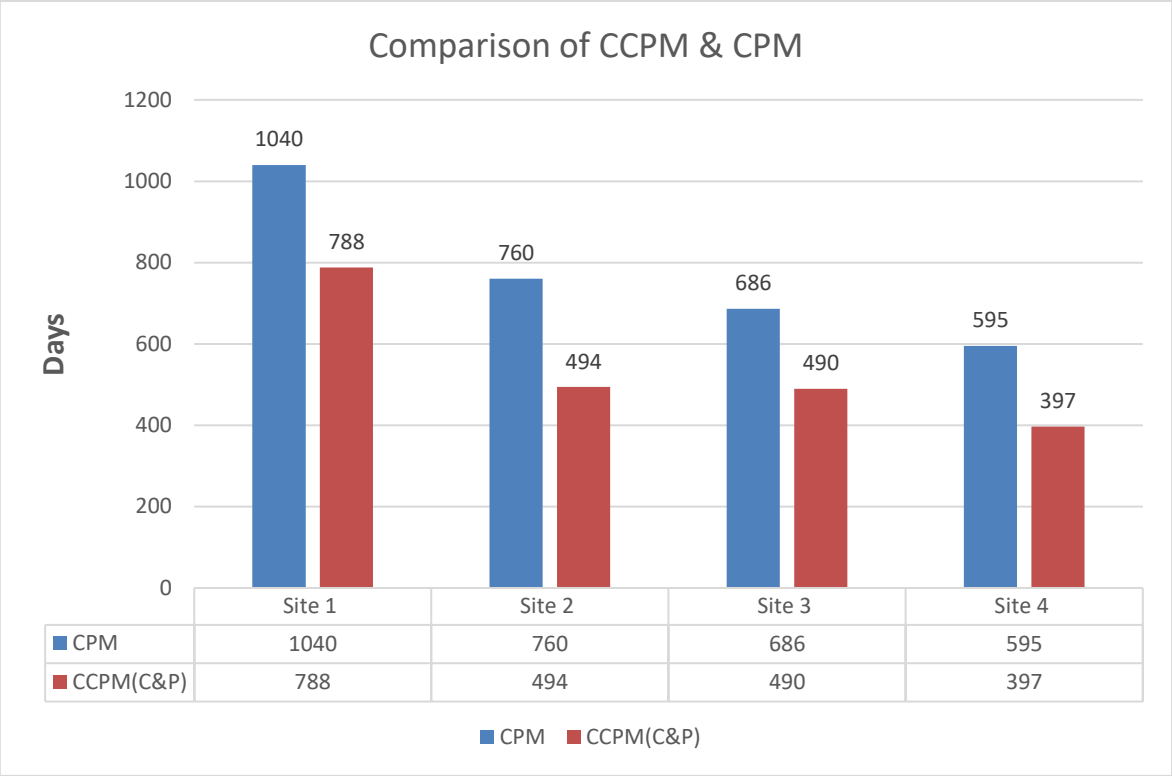



***Figure 10 Graph of comparison of CCPM and CPM***

## VII. CONCLUSION

From all case studies, we can see the difference in the time duration of the project. In CPM methodology the time duration is high whereas in CCPM methodology the time duration is less as compared to CPM. As shown in the analysis in case study 1 the time duration is reduced by **452 days** after applying the CCPM method by cut and paste buffer sizing. Same as in case studies 2,3, and 4 the result of a reduction of the days are **366 days**, **346 days**, and **328 days** respectively.
In traditional methods, there are some difficulties and it is time taking method. Whereas by various buffer sizing methods and proper buffer management we can easily reduce the time duration of the project which is indirectly affecting on cost also.
In all crux of analysis, conclude that the CCPM methodology is far better than the CPM methodology.

## VIII. REFERENCES

1. Abisha, M. R., & Sowmiya, S. v. (2019). Engineering & Technology (A High Impact Factor. *International Journal of Innovative Research in Science*, *8*. https://doi.org/10.15680/IJIRSET.2019.0803150

2. Chhaya, D., Gohil, P., & Tech Student, M. (2019). To Compare CPM & CCPM Methodology for Canal Construction. In *IJSRD-International Journal for Scientific Research & Development*| (Vol. 7). www.ijsrd.com

3. Ghaffari, M., Elmsley, M. W., Ghaffari, M., & Emsley, M. W. (2015). Critical Chain Project Management www.pmworldjournal.net Second Edition Current Status & Future Potential of the Research on Critical Chain Project Management 1. In *PM World Journal Current Status & Future Potential of the Research on: Vol. IV*. www.pmworldlibrary.net

4. Ma, G., Wang, A., Li, N., Gu, L., & Ai, Q. (2014). Improved Critical Chain Project Management Framework for Scheduling Construction Projects. *Journal of Construction Engineering & Management*, *140*(12), 04014055. https://doi.org/10.1061/(asce)co.1943-7862.0000908

5. Patel, T. B., Patel, D. S., & Student, P. G. (2021). TO STUDY THE IMPLEMENTATION OF CRITICAL CHAIN PROJECT MANAGEMENT IN CONSTRUCTION INDUSTRY. In *International Journal of Creative Research Thoughts* (Vol. 9). www.ijcrt.org

6. Prajapati, M. P., & Yadav, N. B. (n.d.). *Buffer Based CCPM Scheduling: A Modern Approach for Indian Constraints*.

7. R&, G. K. (n.d.). *Critical chain: the theory of constraints applied to project management*. http://www.goldratt.com.A

8. Sarkar, D., Babu, R., & Tech, F. M. (2007). Applications of Critical Chain Project Management & Buffer Sizing for Elevated Corridor Metro Rail Project. *International Advanced Research Journal in Science, Engineering & Technology ISO*, *3297*. https://doi.org/10.17148/IARJSET.2016.3702

9. Sinaga, T., & Husin, A. E. (2021). Analysis of time efficiency with ccpm method & bim in construction projects construction of high-rise residential building basement. *Civil Engineering & Architecture*, *9*(5), 1465–1477. https://doi.org/10.13189/CEA.2021.090519

10. Vignesh, M. A. (2019). CRITICAL CHAIN PROJECT MANAGEMENT IN CONSTRUCTION PROJECTS. *International Research Journal of Engineering & Technology*. www.irjet.net