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Analysis of Resource Moment Approach and Release & Rehire Approach for Resource Optimization in Construction Project

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Abstract: Building approaches frequently produce schedules which induce undesired, cost-effective resource variations in the field. Two sorts of situational limitations and resource restrictions occur often with a project manager. The resources for carrying out the tasks are required for a project. These resources comprise the necessary effort, equipment and supplies. The resources in the ideal world are infinite but typically not endless throughout the real world, and the project team needs to level off resource usage.
Keywords: Resource, Levelling, Resource moment, Minimum moment method, RRH.

I. INTRODUCTION

Based on the numerous characteristics, such as significant interdependencies between projects, unsure project character, and the involvement of participants from diverse professions and so on, construction projects are considered to be complicated. This complexity requires, including in order achieving project success, the adoption of sophisticated planning tools rather than traditional approaches. Building projects are not only intrinsically complicated but also have diverse objectives which might be fulfilled in a specified term set forth in contract papers. These goals frequently include more than one aim to be simultaneously optimized. Although in general contradictory, all these goals establish project success criteria. Efficient project management by integrating state-of-the-art technologies would enhance overall project completion process. Network planning approaches frequently require modifying construction plans so as to lower large variations in the use of resources during project lifetime (Harris 1978). As illustrated in Fig. 1, the resource variations on building sites are unworkable, inefficient and cost-effective as (1) necessitate the short-term employment and release of employees; (2) creates problems to recruit and maintain good-quality people and difficult to keep them Unguaranteed (1978 Harr.) steady employment; (3) Cause confusion is who to carried out in curvature learning (Stev. 1990); &/or (4)compel businesses to keep an unproductive labour on the premises keeping some workers idle for periods in low demand; A variety of resource levelling model & algorithms were created to decrease the amount of resource use variations including their adverse influence on building productivity and cost.In order to avoid resource volatility via the relocation of activities on non-critical path with their possible float available, resource levelling models available will maintain its exact early-schedule length of the project. The models proposed and employed several metrics, counting (1) the aggregate of the squares technique, for reducing resource fluctuations (Har. 1978; Skibnie. & Son 1999, Hegaz. 1999; and Band. et al. 1994;); (2) complete differential in use of resources in continuous periods of time; (Adeli. and Seno. 2001; Eldin and Seno. 2004; Easa 1989).The Harris Method of minimum time is one of the methods used to level resources, which proposes to level one resource step by step by creating the histogram for resource until the network has limited all its operations in a timely manner. In addition, Hiyassat suggested an amendment in order to minimize the amount of iterations and calculations in the standard approach. The computation component is decreased by the application of the minimum-time modification technique compared to the conventional method. Hiyassat further proposes that, because of the reduction in calculations, the improved MMT technique may also be employed simultaneously for levelling several resource. Abhay Tawalare offered to modify the minimal time approach by reducing calculation by modifying the selection criteria of the activity to be moved.

II. LITERATURE

Gülçağ Albayrak1 [2020].In this research, (NHA) a novel hybrid algorithm method is used.G.A(genetic algorithm) as well as particle swam optimization (PSO) were combined to create this technique. In order to avoid most prime locations locally and to find the answer, NHA is predicted to be more efficient.A novel approach to project planning and management has been developed by the University of Aberdeen. The study provides a new way of looking at how to maximise the building of a project while keeping safety , quality, environment and resources as well as time, cost and other factors. It will be used in future research into how to improve the construction process.

Tank.Atan etal. [2018]In project management, the levelling of resources is crucial since variations in resources are costly and unwanted. Schedules with higher profiles of resources are usually created by moving the activities to the set duration according to their float times. If the duration of the project can be prolonged, a timetable with an improved levelling of resources is possible since a longer period of time provides more floating time to all the activities. Taking advantage of improved resource levelling by increasing the project length, as the quantity of funds grows. This is because the reverse in other kinds typically offsets an improvement for one or more re-source types. The traditional measure of adding up the squares of daily use of resources, for example, will lead to the longer project length.

Duzgun Agdas [2015].To solve the problem of construction engineering and management's optimization dilemma. In less than 10 minutes, a proprietary G.A is built as well as Used for the resolution of large benchmarking channels of up to 630 very accurate elements. The same approach may be used to solve bigger N/w with 6,300 variables with reasonable accuracy, although it will take longer time. The findings in this paper show that using a metaheuristic method to solve large-scale building challenges is quite successful.

Daisy X.M. Zheng etal. [2002].The global optimum for construction projects has been found using Genetic Algorithms (GA). This is in contrast to more complicated methods for exam. IP, CPM & LP. The findings suggest that GA methods might produce the best T.C.O construction, particularly if the enterprise is big and/or large complicated. A new research by the University of South Wales will look at the TCO issue in greater depth, and the results will be released in due\n\n course.

Mehdi Mrad etal. [2019] the influence of stochastic behaviour of task duration and quality on project cost, duration, and quality is investigated in this study. The computing time required to create simulation results turns out to be surprisingly short, suggesting that it may be used even for huge real-world projects. Furthermore, decreased large-scale time needed and simplicity network computations proved to be highly promising.

Ehsan Eshtehardian etal. [2009]To deal with the uncertainty in activity execution durations and costs, fuzzy sets theory is utilized. To find non-dominated (Pareto) solutions, a fuzzy number comparison and a genetic algorithm are used. Alternate risk acceptance and/or optimism lead to various planning as well as the Pareto solutions that may be used by the project manager. The suggested technique clearly considers the decision maker's risk and optimism in the final choice. Only project managers who are familiar with the fundamental ideas of uncertainty and risk management may use the model.The number of recognized non-dominated fuzzy solutions changed with different choices of β, and the membership of the resulting non-dominant fuzzy solutions altered. For completely fuzzy environment, overall value were shown and pareto solutions ultimate implementation time & no. of fuzzy. Although the question of which option should be implemented from the group remains unresolved.

Mohamed Abo-Zaid etal. [2017]Heuristic approaches and optimization strategies have typically been used to address feasible techniques in project management issues, according to this study. In this article, an optimization model is created that optimises project direct costs while also considering discounted and net cash flow over shortest time period achievable. The model generates a near-optimal solution using a discrete activity time-cost function.

III. OBJECTIVE

This document aims to explain how was developed Innovative levelling of resources which bypass the constraint current techniques and are able to measure directly Reduce the harmful effects of changes in resources Productivity and construction costs, as well as a reliable and realistic model of optimization with newly generated metrics and is able to create optimum and reasonable timetables improve resource use efficiency in buildings projects.

IV. RESOURCE MOMENT APPROACH

It is an heuristic approach used for optimization of the resources it consider the resource histogram as area in the time – resource domain and tries to minimized the moment of that area around the x-axis. In this given set of element is arranged into histogram over a fixed set of interval, minimum moment of the element exists when the histogram is a rectangle over the fixed set of interval.

A. Minimum Moment Method

Harris suggested this method. It has limitless resources and a limited length of the project. According to this idea, If a particular set was structured into a histogram across certain set of intervals (i.e., rectangle), least moment of the elements existed when the histogram was devoid of peaks and valleys. The element time is 1/2 ${Y_i}^2$ around the 0-0 axis. The set's total running time is therefore M = 1/2 $\sum Y^2$. The objective of the theory is to minimize, through non-critical shift operations, the disparities among peaks and troughs with in resource histogram.

The static moment of the new position should have a value lower than old. The activity shift should be made available in its free float. For all actions in the final sequence of the network, a material improvement factor (IF) is determined. IF (activity, S)=R (functional) (functional) Where, IF = Factor improvement; S = number of shifting days;Sx = daily resource amount: x1, x2,...,xm, which must be reduced by m daily resource rate;Sw = daily resource amount: w1, W2,....,wm, which shall be supplemented by m daily resource rate (R); m= minimum of either the day the activity is supposed to be shifted (S) or the day of activity (t), R=resource rate. This algorithm determines most positive element for improvement and shifts the specific action. If factor of improvement is positive or zero, merely changing activities may otherwise not be necessary.

B. A Method used for Minimum Moment Modification

Hiyassat proposes a variation to the classic minimum moment technique in this method. Changes to the selection criteria for the activity that has to be moved. According to this technique, depending on the greatest value of its raw commodity (R) and free float, the activity to be shifted is chosen based on the highest value of its product of resource rate (R) and free float (S). The same improvement factor introduced by the traditional technique determined after selecting activity. R is eliminated as from Eq. in this technique of calculating the improvement factor because its valuation remains consistent throughout time for same action. IF (activity, S) = Σx - Σy – mR If a given activity's improvement factor is negative, the activity cannot be moved. If the improvement factor is positive or zero, activity shifting is permitted. Within the available free float, the selected activity is moved to acquire the most moment. For selecting the next activity to shift, the resource histogram and network diagram are updated. The procedure continues until the first sequence step is reached.

C. Re- Minimum Moment Method Modified

With regard to the selection criteria for activity in sequence network stage, Abhay Tawalare proposed a change in a modified Mind Time technique by hiyassat . According to the assumptions:

1) The logic is fixed in the network.
2) After action has begun till conclusion, no interruption is foreseen.
3) Throughout the execution of each action, resources applied stay constant.
4) Every activity is consistent for a period of time.
5) The ending date of the project is set.

The recommended approach is as follows for resource leveling:

a) The final sequential step activity is evaluated throughout the network.
- Zero free float activities are overlooked.
- With 0 ability rate each activity transferred free-floating bounded to permit movement of previous activities.

b) Activities with positive value and free float rates are calculated and grouped according to R values in increasing order. Greatest amount of R is chosen for activity.
- Where there is a tie in values of R, the activities with the highest value of free float(S) are picked for 2 or even more activities.
- If the activities with the longest length are still bound, for shifting they are to be picked.

c) The improvement factor for all potential slots occupied by the activity is computed with the selected activity in the previous phase. The selected activity will be moved whenever biggest component that improve the specified nil or (+)ve activity. If value of the improving factor is related to multiple among the feasible location, in which the most units are used in different action will be changed. There is a negative element for improvement, no change occurs. The next greatest value action (R) is taken into account.

d) The activity resource rate is removed, if change happens, from each of the everyday resource amounts for the vacant position. Every daily amount in the position is increased to the same pace. The networks are updated for delays, free float, ESD and EFD.

e) R is now picked the next biggest value as well as processor two to four are repeated just before all activities are examined at sequential stage.

f) The following phase is evaluated sooner and steps 1-5 repeat algorithms. This is done until all the work has been taken into account and every conceivable change has occurred in all sequences. That finishes the cycle ahead.

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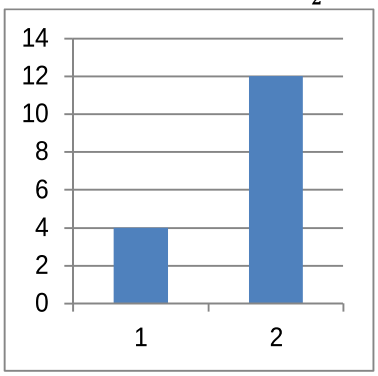
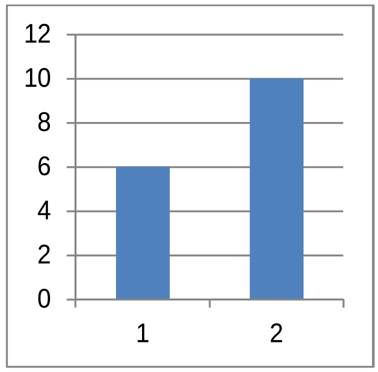
g) Algorithm steps 1 to 6 are repeated from the 1st step by step procedure to the free float of instead, use float back, as well as to the next step in the rather than the previous time position in the sequence, until all actions are considered and moved, where feasible, to an previous place in time. This finalizes the retrograde cycle and the levelling procedure.

An approaches discussed above can effective in generating the minimum moment for the resources to get full utilization of the all available resources.

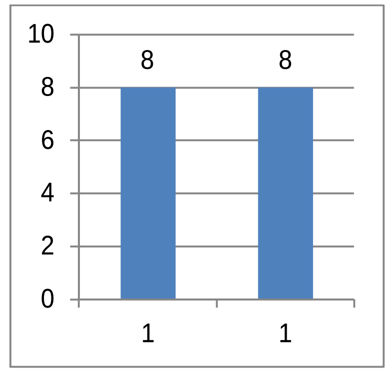
- *Example* – **M (moment) =** $\sum(\boldsymbol{Y} * \frac{\boldsymbol{Y}}{\boldsymbol{2}})$



M=4*4/2+12*12/2
=80



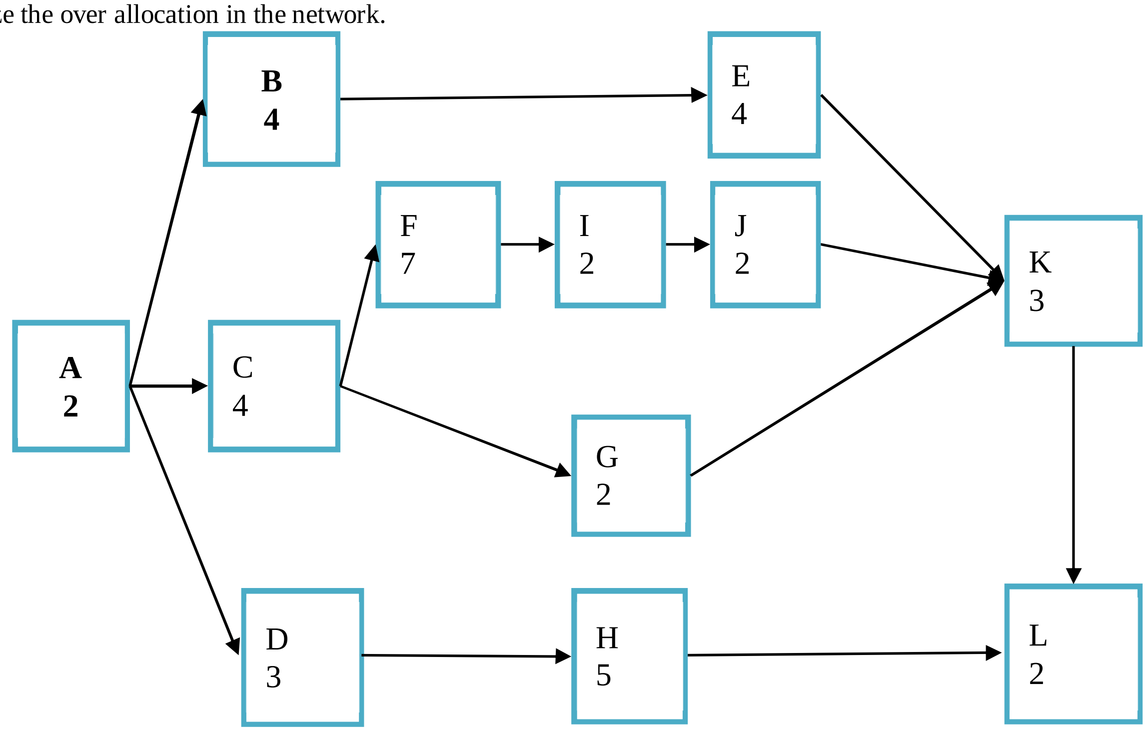
M=6*6/2+10*10/2
=68



M=8*8/2+8*8/2
=64 **MIN VALUE**

From the above histogram it clear that the from the three situation the third histogram is the best idle condition for the use with the minimum moment also.

- *Example -2:* From the below we try find minimum moment of the resource using the available float in the network and try to minimize the over allocation in the network.



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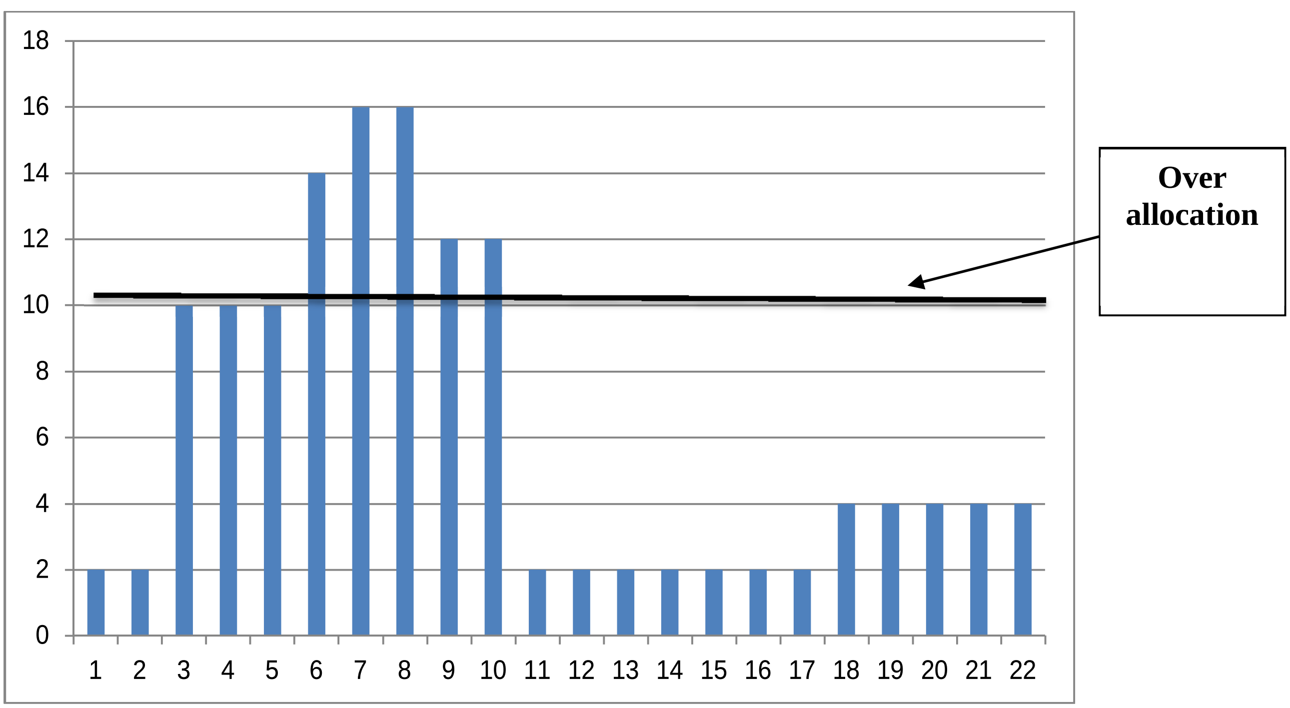
- *Resources Required*

A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***K***	***L***
2	***4***	***4***	***2***	***4***	***2***	***4***	***6***	***2***	***2***	***4***	***4***

- *Solution*

Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A	2	2																				
B			4	4	4	4																
C			4	4	4	4																
D			2	2	2																	
E							4	4	4	4												
F							2	2	2	2	2	2	2									
G							4	4														
H						6	6	6	6	6												
I														2	2							
J																2	2					
K																		4	4	4		
L																					4	4
SUM	2	2	10	10	10	14	16	16	12	12	2	2	2	2	2	2	2	4	4	4	4	4



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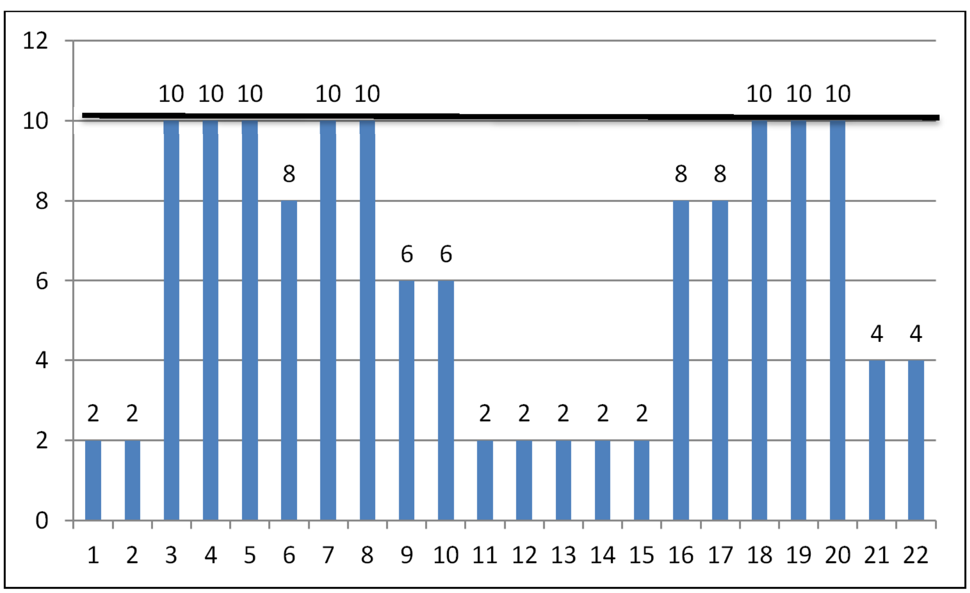
Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A	2	2																				
B			4	4	4	4																
C			4	4	4	4																
D			2	2	2																	
E							4	4	4	4												
F							2	2	2	2	2	2	2									
G							4	4														
H																6	6	6	6	6		
I														2	2							
J																2	2					
K																		4	4	4		
L																					4	4
SUM	2	2	10	10	10	8	10	10	8	8	2	2	2	2	2	8	8	10	10	10	4	4

To resolve over allocation, a float of H was utilised.



Furthermore alternative can be applied on the graph to get the more optimal solution the network with the idle condition for the usage of the resource.

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V. RELEASE AND REHIRE APPROACH

The measurement is intended to measure the overall quantity of resources which must be released temporarily in periods of low demand and subsequently rehired during periods (El-Rayes & Jun, 2009). Huge request of illustrated fig. 1(B). This archetypal uses eq.1 (a) in three consecutive phases for the calculation of Release and Re-Hire (RRH): (1) Compute the daily total (HR), based on Equation (2), summarizing all daily resource demand rises & declines as indicated fig. 1(B); (b) calculate overall daily demand everyday resource rises, that also account for half of the overall fluctuations;(c), through (-) maximum resource demand (MRD) with overall growth in daily resource demand (DRD) as indicated Equation, specifies total quantity of resource released & recovered (1).

$$RRH = H - MRD = \frac{1}{2} * HR - MRD \quad (1)$$

$$HR = [e_1 + \sum_{u=1}^{U-1} |e_u - e_{u+1}| + e_U] \quad (2)$$

$$MRD = Max(e_{1,} e_2, \dots, e_U) \quad (3)$$

Where RHR = total amounts of resources re-hired throughout duration of the system and released temporarily; H = total increases in the amount of the daily demand for resources; HR = total daily fluctuation of resources; U = overall period of the project, e_u= R.D the day (u); e_{u+1}= resource demand on the day (u+1). For enterprises which enable the discharge as well as rehire of construction workers, this technique can be practical and useful. In many other projects which limit such releases and rehire of resources, contractors have been typically obliged to maintain the alternate sources on site idling through periods of less demand, as shown in Fig. 1 (A). Quantifying and minimizing the impact on building productivity and pricing of this decision. Jun et El-Rayes (2009) noted the R.R.H statistics are appropriate for use in assignments if workers are permitted to be released again rehired.

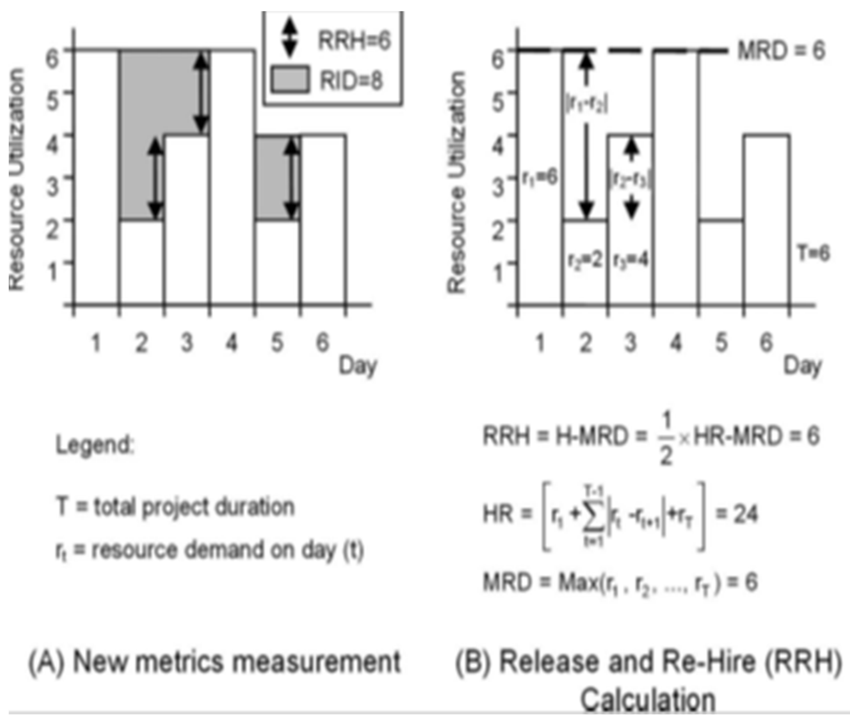

Fig 1: Calculations of the metrics

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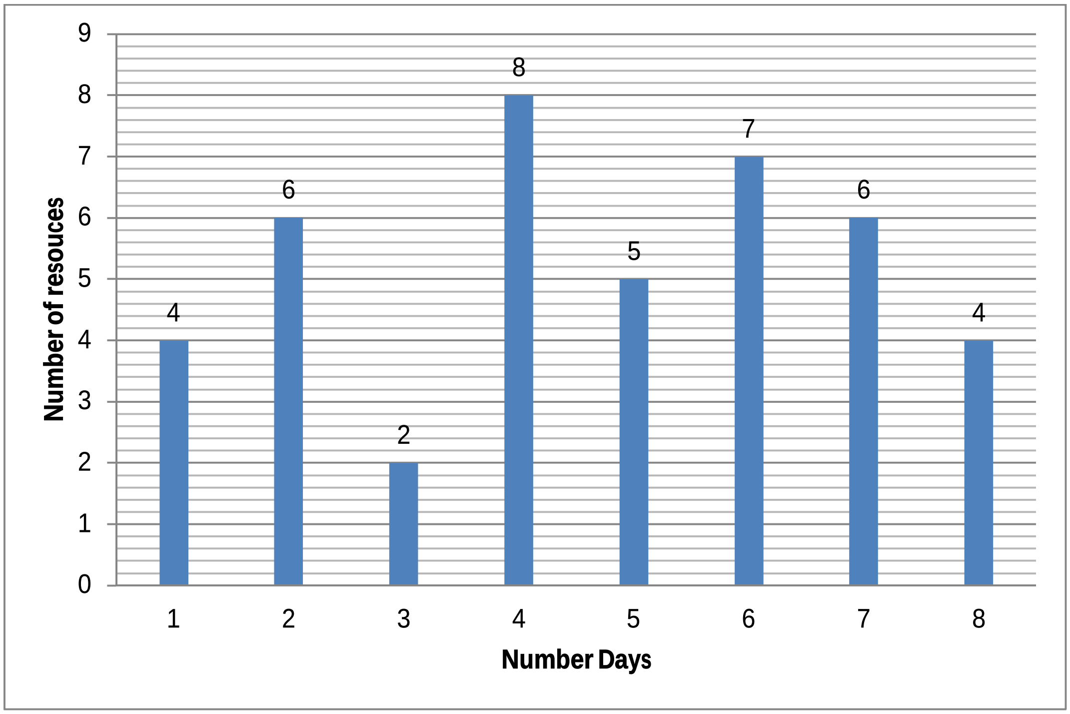
A. Small Example Calculation of RRH

1) Step-1) Compute the overall daily resource fluctuations (HR), and sum of all daily resource demand rises and reductions.

$$HR = [e(1)+ \sum_{u=1}^{U-1}\{e(u) - e(u+1)\}+ e(U)] \quad \textbf{eq. 9}$$

Again, e(1), e(u), e(u+1) and e(U) are the resource requirement in 1^{st}, u^{th}, $(u+1)^{th}$ and U^{th} day of project. A histogram of a 6 day project is shown in Figure 3.1.



Resource Histogram

For above project, the HR is calculated as follows:

HR = [4 + I 4 – 6 I +|6 – 2 |+|2 - 8 I + I 8 – 5 |+|5 – 7 I] +|7-6|+|6-4|+4] = 28

2) Step-2) Calculate the overall materials throughout the everyday resource demand (H), that accounts for half of the overall daily resource swings.

H =HR/2= 14

3) Step-3) Calculate maximum resource demand i.e. MRD = 8.

4) Step-4) RRH = H – MRD = 14 – 8 = 6.

VI. CONCLUSIONS

This study aims to explain the current approach of levelling resources for building projects in India. The major goal of the moment technique for rectangular shaped resource was a review of the minimal moment approach. It is a method to evaluate, illustrate the usage of the model and shows its ability to create an ideal plan which minimizes unwanted resource swings and unusual time periods for resources. This should be helpful to building engineers and planners, and considerable gains in labor productivity and costs in building projects can be achieved. The following study reveals that the method to resource time does not give the ideal answer, but may readily be utilized for a big project level. The greatest efficiency of resource usage idea in building projects are metrics utilized in resources levelling and a robust optimization model. The RRH method provides the basic need for resources The plan is intended to look towards optimal and realistic plans to avoid unwanted resource fluctuations while at the same time decreasing demand for resources. The practical adoption of innovative techniques is hopeful to justify the work invested on planning and planning in order to effectively manage projects and eventually to save real time and costs for projects.

REFERENCES

[1] Abhay Tawalare, Rajesh Lalwani (2013), “Resource Leveling in Construction Projects using Re- Modified Minimum Moment Approach”, World Academy of Science, Engineering and Technology 62 2012

[2] Bandelloni, M., Tucci, M., and Rinaldi, R. (1994).“Optimal resource leveling using non-serial dynamic programming.” Eur. J. Oper. Res., 78(2), 162–177.

[3] Daisy X.M. Zheng, S. Thomas Ng and Mohan M. Kumaraswamy, “APPLYING GENETIC ALGORITHM TECHNIQUES FOR TIME-COST OPTIMIZATION”, In: Greenwood, D (Ed.), 18th Annual ARCOM Conference, 2-4 September 2002, University of Northumbria. Association of Researchers in Construction Management, Vol. 2, 801-10.

[4] Duzgun Agdas, David J. Warne2; Jorge Osio-Norgaard3; and Forrest J. “Utility of Genetic Algorithms for Solving Large-Scale Construction Time-Cost Trade Problems”, © ASCE, 2015.

[5] Ehsan Eshtehardian, Abbas Afshar, Reza Abbasnia, “Fuzzy-based MOGA approach to stochastic time–cost trade-off problem”, Automation in Construction 18 692–701, ELS, 2009.

[6] El-Rayes, K., & Jun, D.H. (2009).Optimizing resource leveling in construction projects.Journal of Construction Engineering and Management, 135(11), 1172–1180.

[7] Gülçağ Albayrak1 “Novel Hybrid Method in Time–Cost Trade Off for Resource Constrained Construction Projects”, Iranian Journal of Science and Technology, Transactions of Civil Engineering, 11 july 2020, springer.

[8] Harris, R. B. (1978),“Precedence and arrow networking techniques for Construction”, Wiley, New York.

[9] Hegazy, T. (1999).“Optimization of resource allocation and leveling using genetic algorithms.” J. Constr. Eng. Manage., 125(3), 167–175.

[10] M. A. Hiyassat, “Applying Modified Minimum Moment Method to Multiple Resource Leveling,” Journal of Construction Engineering and Management, vol. 127, no. 3, May/June 2001.

[11] M. A. Hiyassat, “Modification of Minimum Moment Approach in Resource Leveling,” Journal of Construction Engineering and Management, vol. 126, no. 4, July/August 2000.

[12] Mehdi Mrad , Khalid S. Al-Gahtani2, Rahmeto Hulchafo3, Nizar Souayah 4, And Khaled Bamatraf, “Risk Assessment for Discrete Stochastic Time-Cost-Quality Trade-Off Problem Using Simulation-Based Integer Linear Programming Approach” , March 26, 2019 , IEEE ACESS.

[13] Mohamed Abo-Zaid 1, Tamer El-Korany 2, Emad E. Etman3, Salah El-Din F. Taher, “OPTIMIZATION OF PROJECT TIME-COST TRADE-OFF WITH CONTROLLED CASH FLOWS”, International Conference on Advances in Structural and Geotechnical Engineering ICASGE’17 27-30March 2017, Hurghada, Egypt.

[14] R. B. Harris, “Packing Method for Resource Leveling (PACK),” Journal of Construction Engineering and Management, vol. 116, no. 2, June 1990.

[15] Senouci, A. B., and Eldin, N. N. (2004).“Use of genetic algorithms in resource scheduling of construction projects.” J. Constr. Eng. Manage., 130(6), 869–877.

[16] Son, J., and Skibniewski, M. J. (1999). “Multiheuristic approach for resource leveling problem in construction engineering: hybrid approach.”J. Constr. Eng. Manage., 125(1), 23–31.

[17] Stevens, J. (1990). Techniques for construction network scheduling, McGraw-Hill, New York.

[18] Tankut Atan and Eli. Eren, “Optimal project duration for resource leveling”, European Journal of Operational Research, pp-508–520, © 2018 Elsevier.