Resource Management In Construction Project

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Abstract- Construction industry is the largest industry next to agriculture with huge resources. Construction projects refers to high stake endeavour employing several resources such as men, materials, equipments, etc acheiving predetermined performance objectives using management techniques. Resource management is one of the problems faced day to day in a construction project particularly labour management. In this project, labour are taken as resources in construction of gated community which includes twenty G+1 residential buildings. The details of plan and estimation of a project are prepared as per the building by laws. The estimation of various quantity and labour quantities was arrived based on CPWD standards and IS:7272 – 1974 respectively. The Project management techniques involving scheduling of various activities and resource allocation was done using Microsoft Project 2016. And also involves resource constrained analysis and its corresponding time - cost variations.

Index Terms- Resource Management, Activities Scheduling, Resource leveling, Microsoft Project.

I. INTRODUCTION

These days construction projects have increased due to high demand of infrastructure developement. The fast changing environments of the present days impose financial, legal, ethical, environmental and logistical constraints [14]. Construction activities constitutes an important component of global economy. They interact in several ways such as technically, economically and socially within the environment as well as with other organisation, structures and systems. Eventhough construction projects adopt many resourses, they have difficulties, risks involved in it and each work is labour intensive[11]. There has been lack of attention given to the resource management.

Construction projects contain numerous inter-dependent and inter-related activities. These companies face the challenge of finishing the work within scheduled time and within the budget. It requires various resources and needs time for its completion. The main factor in successful implementation of the project not only depends on the quality and qunatity of work, but also largely depends on utilisation of resources.

Resource management is really a difficult task due to the resource driven nature of construction projects. It is carried out to plan the resources prior to the start of the work. A resource maybe manpower, material, money, equipment, time or space in a construction work. Each activity in construction is allocated with specific resources. The time and cost are directly dependent on the availability of resources[12]. The time required to perform an activity is determined with the resources productivity and the quantity of the work for an activity. The contractor is mainly responsible to identify the interdependencies of various resources combination to perform a activity.

The scope of resource management as,

- The scope of resource management is concerned with personnel aspects such as manpower planning, selection, promotion, training, incentives, labour productivity etc.
- It is also concerned with welfare aspects in dealing with working conditions by providing accomodations, amenities, safety, medical assistance facilities.
- It also enhance the industrial relations among workers with managers, joint consultation, settling disputes, etc.

II. LITERATURE REVIEW

SK.Nagaraju (2012) made a case study about resource management in construction projects. In general construction projets, they employ huge resources of men, materials and machines for major works. Unless required resources are planned and procured, no activity can be executed within scheduled time. Project managers are responsible for taking complex decisions under different scheduling and under conditions of extended task durations. The increased durations results increase in costs.

Maruthi S et.al. (2015) stated, now a days many construction projects are coming out due to high demand of infrastructure developments. In project management, there are two types of resource scheduling problems are resource allocation and resource levelling. The resource allocation in which resources are allocated based on scheduled activities. The resource leveling in which resources are allocated to the critical activities from the non-critical activities. The proper optimization of resources is very important to reduce overall project costs.

Abhishek A. Sutar and Aditya P. Mehendale (2017) stated that construction industry makes a significant contribution to the national economy and provides employment to large number of people. Human resource management plays an important role in the process of project management. Human Resource Management can be done at International construction as well as at the project level. In this paper Organizational structure was developed and it represents key responsibilities of every personnel

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from Proprietor to office boy. It also states the different factors affecting HRM.

I.Othman et.al. (2012) stated that in construction projects, one of the major problem is human resource management. It is still inadequate and insufficient. This paper presents the pilot survey based on HRM in construction of sustainable developement projects regarding years of experience,no. of projects involved and problems faced. The implementation of human resources with insufficient duration got the lowest average index. HRM needs to be improved from time to time for its effectiveness for growth in construction industry.

Renard Yung Jhien Siew (2014) stated that Human Resource management has been evolved as an enabler for sustainability. This paper some concepts of recruitment and performance management are given. He linked several eight competencies such as safe auditing, project risk management, monitoring, communication, etc with the recruitment and performance management. It is mapped to proficiency levels suggested by CRC construction innovation.

Stefanie G. Brandenburg et.al. (2006) has made research study that Centre for Construction Industry Studies have proposed a two tier strategy to workforce management. These metrics are important in facilitating the implementation of an HRM strategy that effectively represents the goals and objectives of the firm. In the Tier I strategy, data are collected regarding background, skill levels of workers. The Tier I strategy got the average score of 6.98 out of 10.0. This provides the scope for further developement of Tier II strategy.

Min-Yuan Cheng et.al. (2005), made a study that human resource planning in construction management process developed a team based human resource planning for deploying labor power. The purpose THRP method is to determine the maximum loading of projects and to identify the range of laborpower required for expected project loadings in the future. In this THRP method, BPR philosopy is applied to integrate organizational functions such as process reengineering, data preparing, human resource allocation and simulation. In a real case study, this method reorganised the structure of the company to facilitate newly designed process and simulation to predict labour power capability for the new organisation.

Wajid Hussain et.al. (2015), stated that due to complex nature of construction projects resource allocation and levelling is one of the top challenges. CPM and PERT is commonly used for scheduling large scale projects. Thi paper briefs about resource allocation and leveling in construction projects. Genetic algorithm was applied in resource allocation and levelling. It's procedure was implemented in MATLAB software. The result shows increase in project duration after resource allocation and leveling for 100 generations.

Jonathan Jingsheng Shi and Daniel W. Halpin (**2013**), in their paper suggests the importance of developing construction enterprise resource planning systems (CERP). They evaluated basic features of CERP such as project oriented, integrated, scalable, transparent, etc. Based on a three-tiered client/server architecture ERP system was developed in order to offer the needed functionality, flexibility, scalability, and reliability. The benefits of a CERP system include information sharing, improved transparency of management responsibilities, and improved management efficiency. The two improved practices improves management efficiency (1) providing timely consistent information; and (2) providing a coordinated decision-making environment.

Rhuta Joshi and Prof. V. Z. Patil (2013), made a case study on resource scheduling of construction project. This paper analyzes the Project management techniques by scheduling various construction activities, allocation of resources and resource leveling using MSP in the form of gantt chart and also analyzes resource constrained project by resource leveling and the time cost alterations with modified durations are analysed.

A.Satish (2018), made a study on evaluation of human resource management. He made a Questionnaire survey from the employees of different construction companies of different levels and it is analyzed with the AHP Model. His findings revealed that Cost is majorly considered by the employees in construction projects with respect to profits of the projects. Time is important in construction projects next to cost.

Malkani Z.A.K. (2013), in his paper stated that the capability to attract, develop and retain competent employees is a key feature of any successful business. Shortage of skilled labours is the problem faced in many construction firms. Reducing the need for labour is the most important aspect in efficient utilization of work force. This paper presents survey that the human resource policy provided by Human Resource department should be used in selection of labour for every work. Efficient use of labour should be made to produce good outcome of construction projects.

Anne Sophie Demilliere, explains about impact of HRM in project management. Good selection, training, and managing are required to adopt labours to form efficient project team. Human resources are carefully indentified and selected to fit with project needs and requirements. The selected resources should be given adequate training to develope their skills and also time consumed in this should be considered. The managing process requires animating, motivating, communicating with the team. It should be done carefully to create project success.

M. Harsha Vardhana Balaji (2017), states that improper resource utilization impacts on various costs, profit margins, quality of the projects, on time completion etc. Critical constructional delays cause high impact in project such as loss of profit margin and time over run. Due to stakeholder's delay 63% of the projects face uncertainty. This is due to the lack of early phase attention and also industrial culture. 70 % of delay in execution by equipment is due to operators. 40% of the projects face depicts of skilled manpower. Employing unskilled labours leads to uncertainties more critical and even it leads to rework.

J. RamaJogi (2017), made a study to discover the nature and degree of wastage, and to find out the various causes of wastage and to quantify the effects of wastage and to find procedure for

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maximum utilization of resources. The resources involved in an activity and its cost awareness is required for resource optimization process. The percentage variance between estimated consumption and actual consumption of resources is about 2 to 12%. Lean principles can be adopted for maximum utilisation of resources.

Dr.K.Divakar and M.Barkath Ali (2015), made a study on factors and problems governing resources management in construction. Datas of survey are collected and a reliability test was performed to determine it's degree of consistency. Ranking is collected and this respondance is checked by analysis of variance. The strength of associations of pairs of variables understudy was determined by correlation relationships.From the test results, main critical factors caused an increase in project duration and cost overruns.

Jianjian Du et.al., made a preliminary study on HRM in international construction. He describes the management of human resource in international cinstruction at international collaboration and at project level. Societal, economical, cultural, workforce are critical factors influencing HRM implementation. The main project participants include the client, contractor, project manager, consultants and government in a construction project have a significant impact on the strategies of HRM. The cost analysis and its benefits is an important for evaluating HRM**.** The economic performance is used for investigating each project participants in HRM implementation.

Agu N.N. and Ugochukwu. S (2016), made a study on the prospects of human resources management in enhancing higher productivity in construction industry. The datas was collected about distribution of human resources based on age, experiance, and the prospect of human resource management in enhancing higher productivity, its impacts on employees and impacts on company's goal and objectives. The result of the survey revealed that with well recognized human capital management and efficient human resource management strategies, construction industry can achieve good productivity and financial performance.

Shivendra Tiwari (2018), made a research in resource opimization. The wates generated by building materials is 2 to 3 billion tonnes every year globally, of which 30-40% is only concrete. This research describes the methods of reducing the wastages of construction materials and its prevention at site. The source of material wastages in different stages are studied. Optimizing resource utilization can help to reduce time and cost. Genetic algorithm technique is adopted to get an optimal solution. Without recycling, the project progress delays. The efficient management of material resource indicates the success of project.

Biren Patel (2017), made a review in labour productivity. Labour productivity contributes to profitability of construction projects. With proper labour management, good labour productivity can be achieved Major factor affecting labour productivity are low payment, poor construction methods, use of technology/level of mechanization, delay in material delivery etc. The labour productivity can be improved by maximizing workload focusing on workflow.

III. METHODOLOGY ADOPTED

The methodologies adopted in this project work were both qualitative and quantitative.

The work was carried out in two phases,

- In the first phase, all the informations and data needed to estimate the resources were collected. The estimate of activities in construction of gated community was prepared. Then requirement of resources for each activities were calculated.
- In the second phase, with the estimated resources, the construction project schedule has been prepared and resources were tabulated for each activity. The actual resources available for the project were analysed with modified duration. The time cost implications have been analysed to alert the management.

A. Project Data Collection

The preliminary work in this project work is data collection. Data collection is the process of collection of information which can be used to measure and evaluate the outcomes. The datas such as area, location, structural details were gathered. The area of gated community is presented in Table 1.

Table -1: Area detail of the Gated community

Area Description	Sq.ft	Sq.m
Total area of the site	146791	13211.19
Area of Ground floor (G+1)	1933	173.97
Area of First floor(G+1)	1580	142.2
Total area of 20 nos of G+1	70260	6323.4

B. Estimation of Project

The estimation of gated community were carried out manually according to the detail plan. The rates of each quantity were calculated as per the Central Public Works department standard rates. The estimation of project includes both direct and indirect cost (10%). The total estimation cost of project was calculated approximately as Rs. 16,07,73,376.

C. Estimation of Labour Resources

Labour requirement was calculated with the labour output constant as per IS:7272 – 1974(Part I) and with the estimated quantity for each work. Some of output constants for different activities are shown in Table 2 and Table 3.

Table -2: Manpower output constants for different labours as per IS: 7272-1974 (Part I)

Activity	Labour output per day
1. Unskilled workers - Excavation	1.5 M^3

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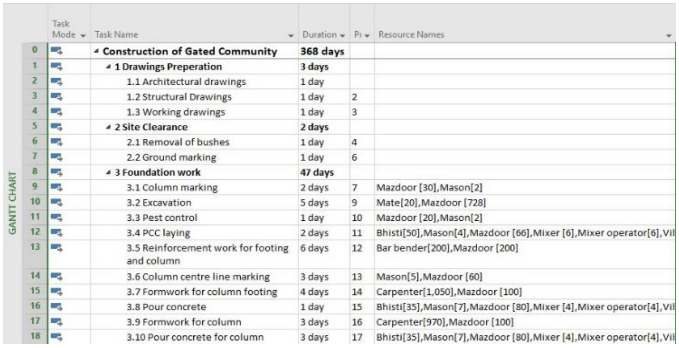
- PCC and concrete	0.2 M^3
2. Carpenters	6.0 M^2
3. Barbenders	0.2 MT
4. Masons (includes shifting of materials within the site, wetting in water and dressing in Size stone masonry) - SSM - Block Masonry - Plastering	0.9 M^3 6.0 M^2 6.0 M^2 8.0 M^2
5. Painters	10.0 M^2

Table -3: Manpower required foe various works as per CPWD analysis of rates

Activity	Per Unit	Mason	Bhisti	Mazdoor
Plain cement cincrete(PCC)	1 cum	0.1	0.7	1.63
Barbending work	1 ton	7.5	-	10
Shuttering work	4 sqm	1	-	1
Reinforced Cement Concrete(RCC)	1 cum	0.17	0.9	2
Masonry work	1 cum	0.72	0.217	1.56
Plastering work	10 sqm	0.67	0.93	0.86
Painting work	10 sqm	0.54	-	0.54

D. Preparation of Project Schedule

The schedule contains different types of activities involved in entire construction with different durations based on the type of work. Microsoft Project software is used to prepare schedule. From these scheduled works manpower required were listed and realistic durations in the current situations was accounted and durations were calculated. Based on the data obtained, network diagram has been prepared and relations were assigned to the activities to calculate the critical path. The total duration of the project was estimated as 368 days as shown in Fig-1.



	Task Mode	Task Name	Duration	Pr	Resource Names
0		**Construction of Gated Community**	**368 days**		
1		**1 Drawings Preperation**	**3 days**		
2		1.1 Architectural drawings	1 day		
3		1.2 Structural Drawings	1 day	2	
4		1.3 Working drawings	1 day	3	
5		**2 Site Clearance**	**2 days**		
6		2.1 Removal of bushes	1 day	4	
7		2.2 Ground marking	1 day	6	
8		**3 Foundation work**	**47 days**		
9		3.1 Column marking	2 days	7	Mazdoor [30],Mason[2]
10		3.2 Excavation	5 days	9	Mate[20],Mazdoor [728]
11		3.3 Pest control	1 day	10	Mazdoor [20],Mason[2]
12		3.4 PCC laying	2 days	11	Bhisti[50],Mason[4],Mazdoor [66],Mixer [6],Mixer operator[6],Vi
13		3.5 Reinforcement work for footing and column	6 days	12	Bar bender[200],Mazdoor [200]
14		3.6 Column centre line marking	3 days	13	Mason[5],Mazdoor [60]
15		3.7 Formwork for column footing	4 days	14	Carpenter[1,050],Mazdoor [100]
16		3.8 Pour concrete	1 day	15	Bhisti[35],Mason[7],Mazdoor [80],Mixer [4],Mixer operator[4],Vi
17		3.9 Formwork for column	3 days	16	Carpenter[970],Mazdoor [100]
18		3.10 Pour concrete for column	3 days	17	Bhisti[35],Mason[7],Mazdoor [80],Mixer [4],Mixer operator[4],Vi

GANTT CHART

Fig -1: Microsoft Project Schedule with duration of 368 days

E. Resource Constrained Analysis

Resource constrained analysis were done to produce resource histograms of various activities involved in project. Resource histograms provides the scheduled dates for which resources are allocated. Critical activities were identified from the project schedule. By modifying the duration of the project, resource leveling and resource optimization were done under constrained resources and based on that time-cost variations for increased durations were obtained.

While doing resource constrained analysis major resources employed in this project were taken into account namely, Masons, Mazdoors, Bar benders, Carpenters, Painters. For each resource type peak demand is identified and resource constraints were reduced to 10% each for six trails.

E.a Analysis for Masons

In masons histogram, peak units for an activity is found to be 600 numbers. With the total duration of project being 368 days, total masons duration is 185 days for all activities. In the first trail, resource constraints for masons were reduced to 10% i.e.,540 masons and resources were levelled. Figure 2 represents Resource graph showing Peak mason allocation. Correspondingly six trails results are shown in Table 4.

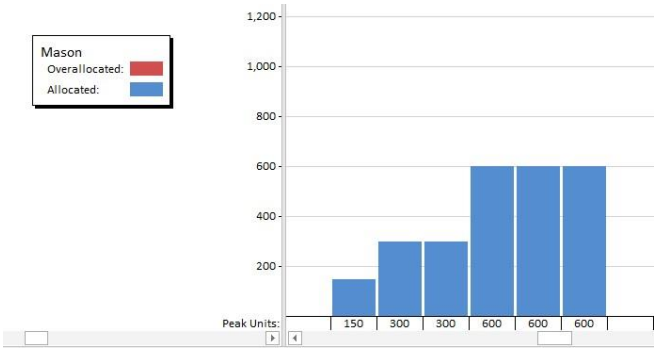


Fig -2: Peak Mason Allocation

Table -4: Resource constrained analysis for masons

Resource constraints	600	540	480	420	360	300
Durations for masons	185	185.66	186.5	187.58	189	191
Total increased duration	368	368.66	369.5	370.58	372	374

E.b Analysis for Mazdoors

In mazdoors histogram, peak units for an activity is identified as 1500 and total durations for mazdoors is found to be 323 days. Figure 3 represents Resource graph showing Peak mazdoor allocation. The results for six trails with reduced constraints of 10% each are shown in Table 5.

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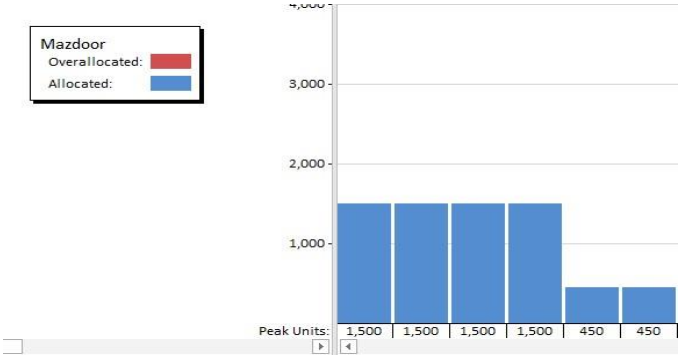

Fig -3: Peak Mazdoor Allocation

Table -5: Resource constrained analysis for mazdoors

Resource constraints	1500	1350	1200	1050	900	750
Durations for mazdoors	323	323.66	324.5	325.58	327	329
Total increased duration	368	368.66	369.5	370.58	372	374

E.c Analysis for Bar benders

In bar benders histogram, peak units for an activity is identified as 600 and total durations for mazdoors is found to be 31 days. Figure 4 represents Resource graph showing Peak bar benders allocation. The results for six trails with reduced constraints of 10% each are shown in Table 6.

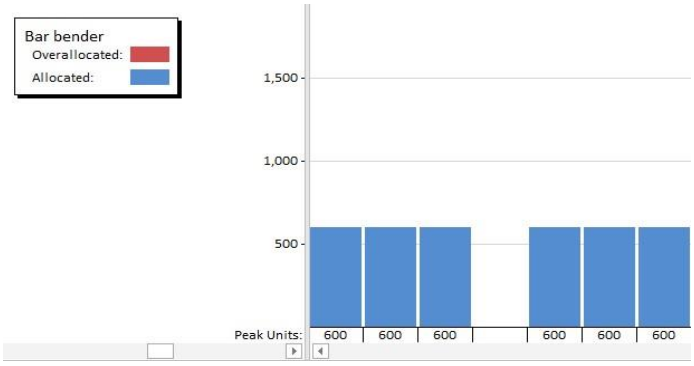

Fig -4: Peak Bar bender Allocation

Table -6: Resource constrained analysis for bar benders

Resource constraints	600	540	480	420	360	300
Durations for bar benders	31	32.12	33.5	35.28	37.66	41
Total increased duration	368	369.12	370.5	372.28	374.66	378

E.d Analysis for Carpenters

In carpenters histogram, peak units for an activity is identified as 1300 and total durations for mazdoors is found to be 75 days. Figure 5 represents Resource graph showing Peak carpenters allocation. The results for six trails with reduced constraints of 10% each are shown in Table 7.

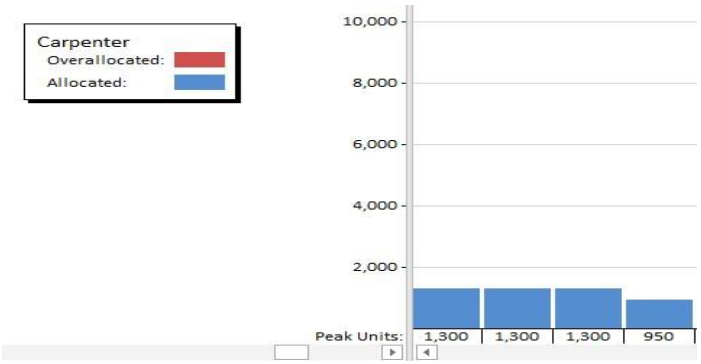

Fig -5: Peak Carpenters Allocation

Table -7: Resource constrained analysis for carpenters

Resource constraints	1300	1170	1040	910	780	650
Durations for carpenters	75	75.56	76.25	77.14	78.33	80
Total increased duration	368	368.56	369.25	370.14	371.33	373

E.e Analysis for Painters

In painters histogram, peak units for an activity is identified as 1800 and total durations for mazdoors is found to be 12 days. Figure 6 represents Resource graph showing Peak painters allocation. The results for six trails with reduced constraints of 10% each are shown in Table 8,

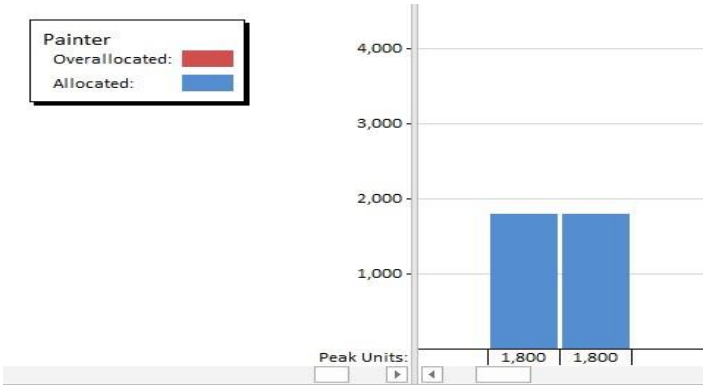

Fig -6: Peak Painters Allocation

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Table -8: Resource constrained analysis for painters

Resource constraints	1800	1620	1440	1260	1080	900
Durations for painters	12	12.22	12.5	12.86	13.33	14
Total increased duration	368	368.22	368.5	368.86	369.33	370

F. Time-Cost Variations

The Budgeted cost for the project = Rs 16,07,73,376

Total Indirect cost = Rs 1,60,77,337.6

Avearge Indirect cost per month = Rs 1339778.13

Indirect cost per day = Rs 44659.27

F.a Variations due to Masons and Mazdoors

Since the increased durations of both masons and mazdoors are similar, it results in same increased cost. Time-cost variations due to reduced constraints on masons and mazdoors are represented in Table 9. Figure 7 represents graph showing increased durations vs increased cost.

Table -9: Time-cost variations due to masons and mazdoors

Increased durtion in days	Increased cost in Rs	% increase in cost
368	160773376	0
368.66	160802851.1	0.018
369.5	160840364.9	0.023
370.58	160888596.9	0.030
372	160952013	0.039
374	161041331.6	0.055

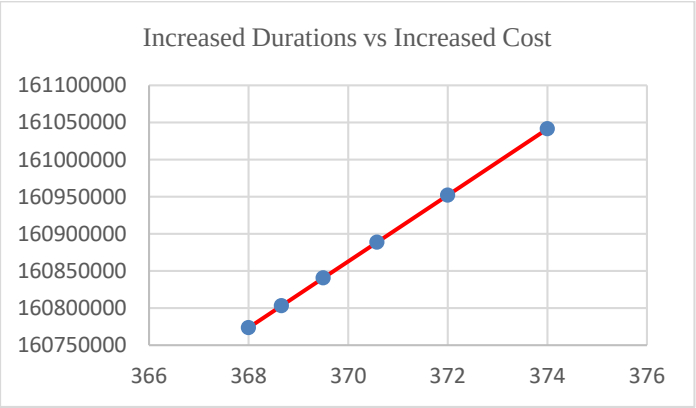

Fig -7: Increased durations vs Increased costs

F.b Variations due to Bar benders

The increased cost corresponding to the increased duration due to reduced constraints on bar benders is represented in Table 10. Figure 8 represents graph showing increased durations vs increased cost due to bar benders.

Table -10: Time-cost variations due to bar benders

Increased durtion in days	Increased cost in Rs	% increase in cost
368	160773376	0
369.12	160823394.3	0.031
370.5	160885024.1	0.038
372.28	160964517.6	0.049
374.66	161070806.7	0.066
378	161219968.7	0.093

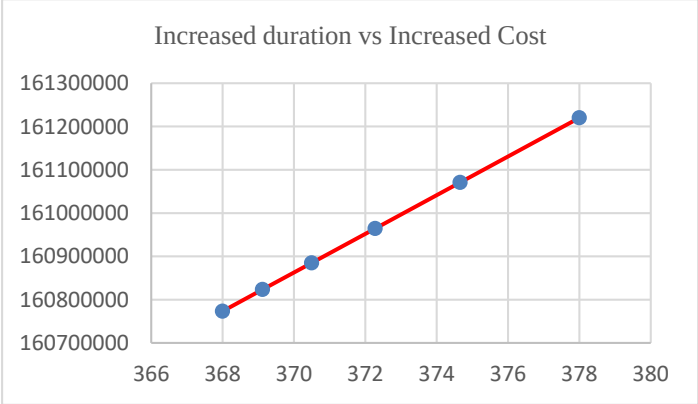

Fig -8: Increased durations vs Increased costs due to bar benders

F.c Variations due to Carpenters

The increased cost corresponding to the increased duration due to reduced constraints on carpenters is represented in Table 11. Figure 9 represents graph showing increased durations vs increased cost due to carpenters.

Table -11: Time-cost variations due to carpenters

Increased durtion in days	Increased cost in Rs	% increase in cost
368	160773376	0
368.56	160798385.1	0.016
369.25	160829200	0.019
370.14	160868946.8	0.025
371.33	160922091.3	0.033
373	160996672.3	0.046

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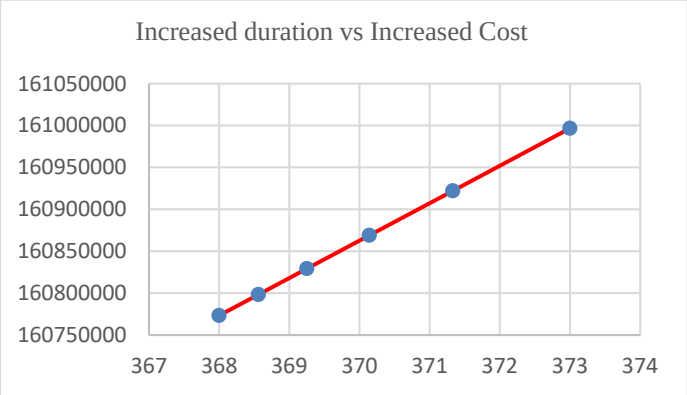

Fig -9: Increased durations vs Increased costs due to carpenters

F.d Variations due to Painters

The increased cost corresponding to the increased duration due to reduced constraints on painters is represented in Table 12. Figure 10 represents graph showing increased durations vs increased cost due to painters.

Table -12: Time-cost variations due to painters

Increased durtion in days	Increased cost in Rs	% increase in cost
368	160773376	0
368.22	160783201	0.006
368.5	160795705.6	0.008
368.86	160811782.9	0.010
369.33	160832772.8	0.013
370	160862694.5	0.019

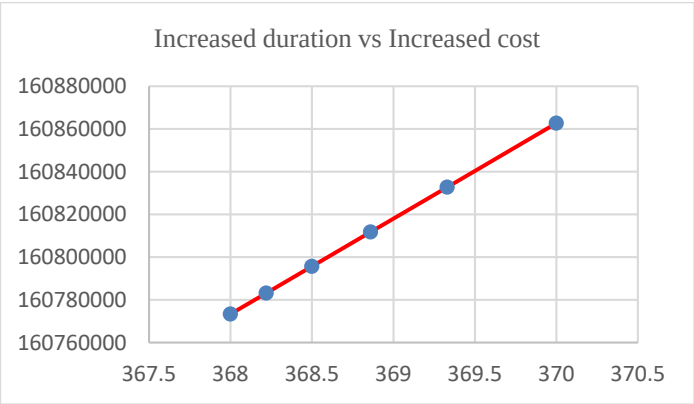

Fig -10: Increased durations vs Increased costs due to painters

IV. DISCUSSION ON RESULTS

The initial duration for the project scheduled was 368 days. But after the process of resource constrained analysis involving resource optimization and resource leveling, project duration varies gradually.

It was obtained that, with the resource constrained analysis on masons and mazdoors, project duration increases from 368 to 374 days with %increase of 0.055 in total project costs. An analysis over bar benders results increase in project duration from 368 to 378 days with % increase of 0.093 in project cost. An analysis over carpenters results increase in project duration from 368 to 373 days with % increase of 0.046 in project cost. An analysis over painters results increase of two days in project duration with % increase of 0.019 in project cost. Thus the total project costs increases upto Rs. 4,46,592.7.

V. CONCLUSION

Thus in a construction project, resource management is the main challenge especially manpower (labour) management. The shortages of labour resources gradually increases time and cost involved in a project. The allocation of required resources is needed to complete a project within scheduled time. This paper presents the preperation of required labour resources according to the scheduled activities in construction of gated community and also presents resource constrained analysis which involves resource leveling and resource optimization. Based on the analysis time-cost variations were obtained. It was observed that, for decrease in resource constraints there is an increase in project durations from 368 days upto 378 days according to various resources. When the project duration increaes, it apparently results an increaes in total project costs from 0.006% to 0.093% accordingly.

REFERENCES

[1] Abhishek A. Sutar and Aditya P. Mehendale, "Overview Of Human Resource Management System In Construction Industry", International Journal of Advanced Research and Publications, December 2017, Vol. 1, pp. 81-84.

[2] Agu.N. N and Ugochukwu. S, "Prospect Of Human Resources Management In Enhancing Higher Productivity In Construction Industries In Enugu State, Nigeria", International Journal of Innovative Science, Engineering & Technology, August 2016, Vol. 3, pp. 416-424.

[3] Anne-Sophie Demilliere, "The Role of Human Resources in Project Management", Journal of Economic Literature, pp. 1-11.

[4] Barkath Ali. M and Dr. K.Divakar, "Study on Factors and Problems Governing Resource Management in Construction Industry", International Research Journal of Engineering and Technology, April 2015, Vol.2, pp. 460-464.

[5] Biren Patell, Prof J. J. Bhavsar and Dr. Jayeshkumar Pitroda (2017), "A Critical Literature Review of Labour Productivity in Building Construction", International Journal of Constructive Research in Civil Engineering, 2017, Vol. 3, pp. 76-80.

[6] Central Public Work Department (CPWD), "Analysis of Rates", Director General (Works) CPWD, New Delhi.

[7] Harsha Vardhana Balaji. M and Dr. Pulidindhi Venugopal, "Resource Utilization in Construction Projects and it's Impacts of High Ranked Variable During Time Overrun: A Review", Technical Research Organisation India, 2017, Vol.4, pp. 31-35.

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[8] Indian Standard Recommendations for Labour output Constants for Building Work, IS : 7272 (Part I) – 1974.

[9] Jianjian Du, Chunlu Liu and David Picken, "A Preliminary Study on Human Resource Management in International Construction", The Australasian Journal of Construction Economics and Building, Vol. 7, pp. 1-11.

[10] Jonathan Jingsheng Shi and Daniel W. Halpin, "Enterprise Resource Planning for Construction Business Management", Journal of Construction Engineering and Management, March/April 2003, Vol. 129, pp. 214-221.

[11] Malkani .Z.A.K and Kambekar .A.R, "Management of Human Resource in Construction Industry", International Journal of Engineering Research and Technology, 2013, Vol. 6, pp. 353-362.

[12] Maruthi S, Dr. J.R.Patil and Rohit S. Agawane, "Optimization for Fluctuation in Resource Demands in Construction Projects", International Research Journal of Engineering and Technology, June 2015, Vol. 2, pp. 1289-1296 .

[13] Min-Yuan Cheng, Ming-Hsiu Tsai and Zhi-Wei Xiao, "Construction management process reengineering: Organizational human resource planning for multiple projects", Automation in Construction, 2006, Vol. 15, pp. 785–799.

[14] Nagaraju SK., "Resource Management in Construction Projects – a case study", Engineering Science and Technology: An International Journal, August 2012, Vol. 2, pp. 660-665.

[15] Othman I.,Idrus A. and Napiah. M, "Human resource management in the construction of a sustainable development project: towards successful completion", WIT Transactions on Ecology and The Environment, 2012, Vol. 162, pp. 169-180.

[16] RamaJogi. J and Asadi. SS, "Optimal Resources Utilization in Construction Industry", International Journal of Civil Engineering and Technology, January 2017, Vol. 8, pp. 273-280.

[17] Renard Yung Jhien Siew, "Human Resource Management in the Construction Industry -Sustainability Competencies", Australasian Journal of Construction Economics and Building, 2014, Vol. 14, pp. 87-103.

[18] Rhuta Joshi and Prof. V. Z. Patil, "Resource Scheduling of Construction Project: Case Study", International Journal of Science and Research, May 2015, Vol. 4, pp. 563-568.

[19] Satish. A, Prasanna Kumar. D, "Evaluation OF Human Resources Management in Construction Industry Using Analytical Approach: A Model Study", International Journal of Mechanical Engineering and Technology, February 2018, Vol. 9, pp. 95–104.

[20] Shivendra Tiwari, Rajendra B. Magar and Abdulrazzak Honnutagi, "Resource Optimization for Sustainable Construction: A State of Art", International Advanced Research Journal in Science, Engineering and Technology, February 2018, Vol. 5, pp. 69-73 .

[21] Stefanie G. Brandenburg, Carl T. Haas and Keith Byrom, "Strategic Management of Human Resources in Construction", Journal of Management in Engineering, April 2006, Vol. 22, pp. 89-96.

[22] Wajid Hussain, Dr.M.K.Trivedi and Dr. R. Kansal, "Optimisation of Construction Resource Allocation and Levelling Using Genetic Algorithm", International Journal of Innovative Research in Science, Engineering and Technology, June 2015, Vol.4, pp. 4573-4578.

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