RESOURCE OPTIMIZATION IN CONSTRUCTION

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Abstract— In the light of increasingly challenging business environment, construction companies are taking a closer look at their operations, searching for untapped profit-boosting opportunities and new source of competitive differentiation. Many executive are discovering various processes for effective management of refocuses used in the construction industry; this is referred as construction resource management. Therefore it is one of the most important aspects of construction project management in today's economy because the construction industry is resource-intensive and the cost of construction resource have steadily raised over the last several decades. The aim of the study is to estimate the influence of various factors in the productivity of resource used in construction project. The main focus has been kept in identifying the various factors affecting the productivity of manpower, material and machines used in construction industries, so that a well-defined correlation between resources and their productivity can be established. This management system will help in utilizing the construction resources in efficient manner, so that the construction project can be completed in time with framed budget.

***Keywords*— Factors affecting the productivity of manpower, material and machines.**

I. INTRODUCTION

Resource optimization is the processed scheduled and methods to match the available resource (men, material, machinery and money) with the needs of the organization in order to established goals. Optimization consist in attaining desired outcome within a set time and budget with minimum practice of the resource themselves. The importance of Resource Optimization are Better productivity, Better accountability, Decreasing human error, Maintenance, Reduce cost and Better knowledge of inventory. The objectives are To identify the critical influencing the productivity of the resource. To assess correlation between the dependent variable (resource optimization) and independent variable (factors influencing the productivity of the resources) using SPSS software. To develop a model for resource optimization in the construction projects. It is limited to make efficient use of resources that is manpower, material, and machine in construction industry thereby optimizing the resources in construction.

II. LITERATURE REVIEW

Arashpour et al. (2015) presented that traditional approaches in construction project management assign each process to a trade contractor with an individual specialization, and trades with the greatest work content (bottlenecks) had a significant, influence on the progress rate of projects. A system with integrated processes, however, was able to function dynamically in response to variability in product demand and labour resources. This paper aimed at cross-training strategies that were applicable to off-site construction in order to create multi-skilled resources. To this end, the optimal number of additional skills was formulated as a constrained optimization problem. Then, production data from two prefabricated production facilities in Melbourne and Brisbane, Australia were used to construct a total of 1080 simulation experiments. Tangible performance metrics of systems were used to compare process integration strategies and use of multi-skilled resources.

Naskoudakis et al. (2016) had emphasized on the use of robotics and automation (R&A) technology had become essential to construction project success and creates possibilities for the construction company to realize a competitive advantage. A popular subtheme here was "unmanned construction", i.e., work performed by remotely operated construction machinery that corresponds to an operator controlled robot. In incompletely characterized environments with exposure in hard and severe conditions, remote machine operation was the efficient solution for the operation of construction machines. Example, a remote control system for backhoe with a pneumatic robot system, or an excavator having tele-operation system with movements of a human arm.

Bharathkumar Malpani (2016) had explained primavera project management that allows us to optimize the use of resources by delaying activities and adjusting resources to reduce the peaks in the histogram. When this feature was used, the length of project may be extended. The resource levelling problem comes in the project because of the project duration is fixed. Most projects have a completion date, specified in contract document. If any over allocation in resource exists, then for reduce the over allocation resource levelling can used. Mainly there were two types of resource levelling in primavera P6.Automatic levelling, Manual levelling. The author suggested

the primavera P6 was best specified as tool for resource scheduling of residential projects and any other projects and assessment of resource optimization for a formulated resources.

Bavi et al. (2017) stated that planning and scheduling was an important techniques of the management. Planning was necessary to understand the proper utilization of human and material resource and to tackle the problems related to delay of construction projects". Commonly CPM/PERT methods was widely used for scheduling of the project which helps the project management CPM was better compare to PERT method. CPM method was reliable to management is provides minimum time need to complete the project and also gives the information about future problems related to delay of project.

III. Data Collection

The right personnel for the right position is a sure bet for organizational effectiveness and efficiency. The lateness and absenteeism, hazardous acts, alcoholism, improper training, incompetence are some of the attributes of man at work. Human resources determine the workings of the other three basic resources.

3.1 QUESTIONAIRE DESIGN

The questionnaire was framed for collecting the response from respondents on the earlier identified different factors affecting the productivity of the resources. Respondents were asked to rate each of the factors on the short likert scale from one to five rating. Respondents were asked to either circle or put a tick mark on which they felt was the impact of the particular factor in governing the productivity of the resources.

TABLE 3.1: LIKERT SCALE DEFINITION

Rating	Likelihood	Description
1	Very low	Highly unlikely to occur. May occur in exceptional situations.
2	Low	Most likely will not occur. Infrequent occurrence in past projects.
3	Moderate	Possible to occur.
4	High	Likely to occur. Has occurred in past projects.
5	Very high	Highly likely to occur. Has occurred in past projects and conditions exist for it to occur on this project.

1. **Frequency of occurrence** – it represents what how frequently a particular factor affects the productivity of the resource. If a factor was given 5 rating it means that particular factor is occurring very frequently in construction work.
2. **Severity of the factors** – it represented that if the particular factor is present then what is its impact on the productivity of the resource. Similarly, if any particular factor was given 5 rating it means that particular factor was having very severe impact on the productivity of the resource and hence should be taken care of.

IV. Data Analysis

For obtaining data for analysis following types of projects were taken such as Infrastructure project, Residential project, Institutional and commercial projects. For obtaining the output from the questionnaire different types of populations were considered, who were involved in the project such as Engineers, Assistant managers and Manager.

4.1 RANKING OF FACTORS AFFECTING THE PRODUCTIVITY OF MANPOWER

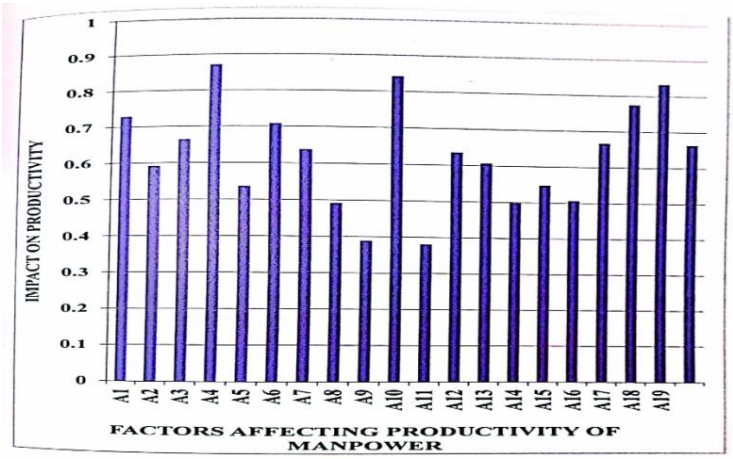

Figure4.1: Factors influencing the productivity of manpower

Factors which affect the productivity of manpower in construction industry

1. Improper coordination between workers, code (A4), RII(0.87)
2. Hazardous working environment for workers, code (A10), RII(0.84)
3. Weather conditions, code (A18), RII(0.78)

Also it is concluded that the factors which were having very low effect on the productivity of manpower in the construction industry are

1. Over manning code (11), RII(0.38)
2. Ripple effect, code(9), RII(0.39)
3. Joint occupancy, code(15), RII(0.50)

4.2 RANKING OF FACTORS AFFECTING THE PRODUCTIVITY OF MATERIAL

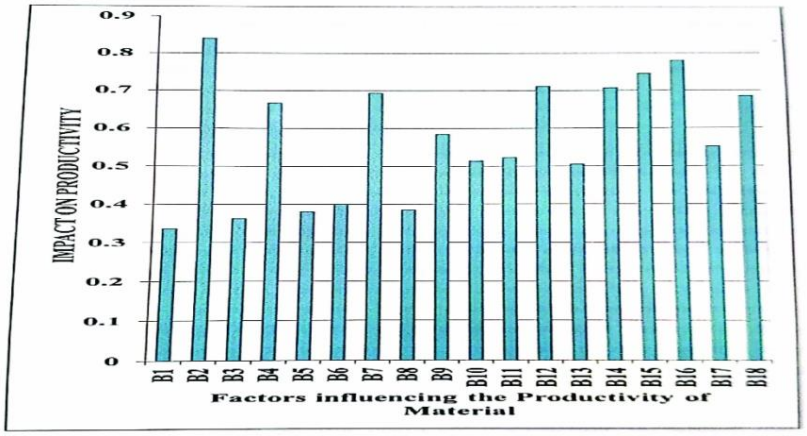

Figure4.2: Factors influencing the productivity of material

Factors for material management in construction work are

1. Escalation of material price, code(B2), RII(0.84)
2. Government policies, code (B16), RII(0.78)
3. Poor workmanship/untrained labours code(B15), RII(0. 74)

Factors which are having very low impact on the productivity in construction works are

1. Shortage of the materials, code (B1), RII(0.33)
2. Modification in the material specification, code(B3),RII(0.36)
3. Unavailability of materials, code(B5),RII(0.35)

4.3 RANKING OF FACTORS AFFECTING THE PRODUCTIVITY OF EQUIPMENT

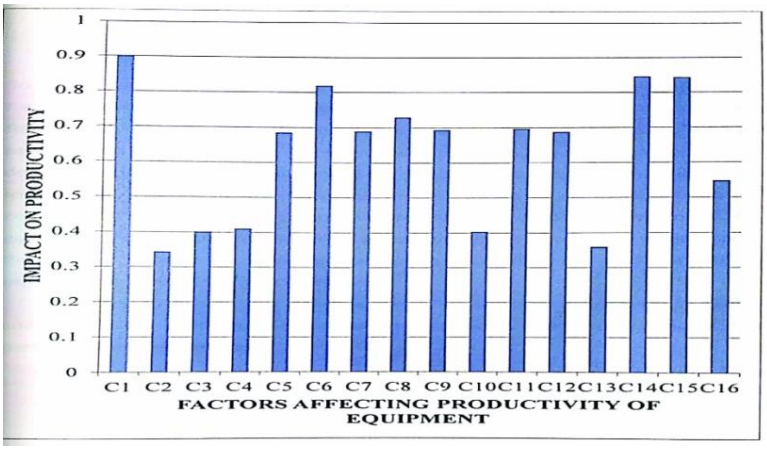

Figure4.3: Factors affecting the productivity of equipment

Factors for equipment productivity are

1. Frequent failure of equipment, code (C1), RII(0.89)
2. Working experience of operator, code (C15), RII(0.85)
3. Working environment of equipment, code (C14), RII(0.84)

Factors having least impact on the productivity of equipment are

1. Delay in supply of equipment, code (C2), RII(0.34)
2. Increase in fuel cost, code (13), RII(0.35)
3. Insufficient number of equipment's, code(10), RII(0.40)

V. RESULTS & DISCUSSION

Final result obtained from the statistical analysis is then later on used to estimate that whether there id dependence in resources productivity and the type of projects through ANOVA analysis, whereas logistic regression done in the study is to obtain the model equation defining the correlation between resources productivity and the factor affecting their productivity. At last model equation is obtained and conclusion is given.

5.1 ANOVA ANALYSIS

Analysis of variance is a statistical method used to test differences between two or more means. Inference about means are made by analysing variance. An ANOVA test is a way to find out if survey or experiment results are significant.

NULL HYPOTHESIS FOR ANNOVA ANALYSIS

There is no significant difference among type of project and factors affecting the productivity of the resources in construction. And the null hypothesis for the analysis will be accepted if the significance value comes in the acceptable region.

Table 5.1: Descriptive table of ANOVA analysis

Resource project type		N	Mean	Std. Dev	F	P
Manpower	Residential	33	62.82	2.84		
	Institutional&	31	63.58	1.61		
	Commercial		62.50	2.10	4.755	0.017
	Infrastructure	26	62.99	2.28		
	Total	90				
Material	Residential	33	56.03	1.68		
	Institutional&	31	56.29	1.69		
	Commercial		56.58	1.65	3.771	0.046
	Infrastructure	26	56.28	1.67		
	Total	90				
Equipment	Residential	33	45.45	2.63		
	Institutional&	30	45.73	2.70		
	Commercial		46.04	2.90	2.334	0.071
	Infrastructure	26	45.72	2.71		
	Total	89				

1. Since the obtained P value is greater than 0.01 hence the null hypothesis is accepted at 1% level of significance, that is there is no significant difference between factors affecting productivity and type of project.

2. Since the obtained P value for manpower and material are less than .05 hence null hypothesis is rejected at 5% level of significance. So it can be concluded that the productivity of manpower and material is dependent on type of project.

3. But as the P value for equipment is greater than .05 hence the null hypothesis is accented for equipment at 5% level of significance. So it can be concluded that factors affecting the productivity of equipment depends not on type of project.

5.2 LOGISTIC REGRESSION ANALYSIS

Logistic regression is a statistical method for analysing a dataset in which there are one or more independent variables that determine an outcome. The outcome is measured with a dichotomous variable. Like all regression analyses, the logistic regression is a predictive analysis. Logistic regression is used to describe data and to explain the relationship between one dependent binary variable and one or more nominal, ordinal, interval or ratio-level independent variables.

Table 5.2: Variables in the Equation

Resources	B	SE	DF	Sig	Exp(B)	95% CI for exp (B)
						LOWER
Manpower	0.193	0.150	1	0.026	1.216	0.818
Material	0.097	0.151	1	0.519	1.102	0.820

Equipment	**0.236**	**0.144**	**1**	**0.019**	**1.327**	**0.693**
Constant	**-0.406**	**0.851**	**1**	**0.634**	**0.667**	

Table 5.2 shows that null hypothesis is rejected for Manpower and Equipment since p value is less than .05(CI=95%) So if effect of the factors are taken then manpower productivity can be increased by 0.193. Similar relationship exist between productivity and equipment that is if factors affecting productivity of equipment is controlled then equipment productivity can be increased but 0.236.

5.3 MODEL EQUATION FOR RESOURCE OPTIMIZATION

By doing logistic regression analysis following relation is established between productivity and manpower. Similarly between productivity and equipment. To obtain correlation between resources and their productivity following

$$\textbf{Log (P) = -0.812+0.193M+0.236E}$$

Where,

P – Productivity, M – manpower, E – Equipment

CONCLUSION FROM ANALYSIS

From above analysis it can be concluded that there is a certain increase in productivity when the impact of the factors affecting the productivity is reduced. From the analysis it is observed that productivity of resources such as manpower, material and equipment was increased from 52.2% to 79.75%.

VI. CONCLUSIONS

Three most predominant factors which are affecting the productivity of manpower in the construction are improper coordination between workers, hazardous working environment for workers& weather conditions. The most predominant factors affecting the productivity of equipment in the construction industry are frequent failure of equipment, working experience of operator & working environment of equipment. Also after performing ANOVA analysis to the obtained data it was concluded that productivity of manpower and material depends on the type of project also (at 5% level of significance). And by doing logistic regression analysis a relation between productivity of manpower as well as factor affecting its productivity & productivity of equipment as well as factors affecting the productivity of the equipment was established.

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