

## STUDY ON RESOURCE PRODUCTIVITY OF A HIGHWAY PROJECT

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**Abstract:** The Construction Industry like any other heavy industries uses huge amount of resources off and on the field in the form of materials, plants & equipment's and human resources along with money, time and space. In highway projects, the total project corridor is usually divided into sections and further to sub-sections for the ease of working and resource allocation. The resources are generally allocated to the working teams / groups on the basis of their productivity level and total volume of work allotted to the respective teams. In highway projects, the same resource is often used for different activities and the productivity of that resource being different for different activities, it becomes inevitable to know the correct norms for correct estimation, planning and monitoring. Apart from project aspects, this study is necessary from global business point of view also. Today, in this globalized business world, any company has to compete with competitors from throughout the globe. In such a situation, optimum usage of resources, according to one pre planned schedule, for the deliverance of an estimated output is an absolute necessity. This could only be done when a system of estimating the resource productivity subject to the project constrains is in place. The main aim of this project is studying resources required for highway construction and increases Resource Productivity in different condition. A detailed study and analysis of the resources' productivity in highway projects is absolutely essential for the prediction of production rate of any team / group and as a whole of a project team. Identification of the factors affecting the productivity of each of the resources along with formation of graphs, formulas and charts to estimate production is also essential for the easy going of the job of planning.

**Keywords—** *Resource Productivity, Planning, Material Management*

### I INTRODUCTION

Construction is an important part of the industrial sector and one of the core sectors in India's economy. India has 142,126 km of National Highways as of April 2019. National Highways constituted 2.7% of India's total road network, but carried about 40% of road traffic, as of 2013. In 2016, the government vowed to double the highway length from 96,000 to 200,000 km. Road transportation has gradually increased over the years with the improvement in connectivity between cities, towns and villages in the country. The Construction Industry uses huge amount of resources off and on the field in the form of materials, plants & equipment's and human resources along with money, time and space. In highway projects, the total project corridor is usually divided into sections and further to sub-sections for the ease of working and resource allocation.

The resources are generally allocated to the working teams / groups on the basis of their productivity level

and total volume of work allotted to the respective teams. Any disparity in the expected level of output compared to actual output level could lead to untimely completion and cost overrun and actually indicate improper prediction of the productivity level leading to wrong estimation of production rate. For the above reasons, it is quite necessary to study the productivity of the different resources in detail for highway sector. The same equipment's and sometimes even the same manpower being used in different activities, a detailed study, categorization and analysis of productivity of resources for different activities are very necessary. Identification of the factors affecting the productivity of each of the resources along with formation of graphs, formulas and charts to estimate production is also essential for the easy going of the job of planning.

Time and cost are two main concerns in a construction and they are used for planning a different project such as infrastructure, roads etc. Construction management is

defined as the application of management techniques and systems in construction to complete projects on budget, on schedule, safely and according to plans and specifications. The advent of powerful microcomputers, the advances in computer hardware and software and their low costs have led to increased utilization of computers in various areas of construction management such as project management, scheduling, cost eliminating, bid mark-up analysis, accounting, submittal management, equipment management, materials management and field management. Large contractors have been steadily increasing their investment in construction equipment to satisfy their needs in response to increased construction volume in recent years. The technical advancement of earthmoving equipment during the 20th century includes many improvements in key parts of machines making the machine mechanically more efficient. Hence major large construction operations and mega projects uses a large number of various construction equipment's. The fleet operations have become complex due to large number of manufactures, various capacity and sizes of equipment available which makes the equipment selection the complexity further increases to optimize the size and number construction equipment's in the fleet. Fleet management consists of conceptual sub-components such as equipment selection and assignment, equipment optimization, maintenance, production monitoring, material and position monitoring etc.

To execute such variable works in different phases of project, any big construction company has to keep artillery of various plants and equipment's supported by an army of skilled and semiskilled manpower. In highway projects, the total project corridor is usually divided into sections and further to sub-sections for the ease of working and resource allocation. The resources are generally allocated to the working teams / groups on the basis of their productivity level and total volume of work allotted to the respective teams. Any disparity in the expected level of output compared to actual output level could lead to untimely completion and cost overrun and actually indicate improper prediction of the productivity level leading to wrong estimation of production rate. For the above reasons, it is quite necessary to study the productivity of the different resources in detail for highway sector. The same equipment's and sometimes even the same manpower

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## **II PROBLEM STATEMENT**

To study different resources like Material, equipment, Man-power required for a highway project also studying Resources productivity in different conditions. For detailed study finding out the factors controlling the productivity of each resources and comparative study with different resources

## **III LITERATURE REVIEW**

Study On Resource Planning In Highway Construction Projects<sup>[1]</sup>

K Swarna Kumari, J vikranth

In this paper they studied the resource planning and productivity can, thus help in good resource planning, better monitoring and overall controlling of the project. For the better understand they were taken a case study on B.R.T.S. project at Vishakhapatanam. At the site location they collected data in which the data wise requirement of project manpower, costly equipment, production costs, sales or earned value of work done and expected income. After collection of data they have done resource planning in that Planning of construction work force, planning of construction material, planning of construction equipment. The most general objective of planning is to improve to provide a link between the establishment of an effective productivity measurement system and the human task of improving organizational performance by means of changes in all or several elements of the organization-the people, structure, culture and technology. They observed that in highway projects, the same resource is often used for different activities and the productivity of that resource being different for different activities; it becomes inevitable to know the correct norms for correct estimation, planning and monitoring.

Equipment cost for any project comprises of mainly 20-30% of project cost plus additional cost for maintenance, repair and operation. Cost of equipment has to be controlled properly by efficient allocation of

equipment for different phases of work. So for using equipment effectively and efficiently equipment becomes necessary. Equipment procurement is done after measuring productivity of every equipment. Material cost for any project which is more or less invariable, it depends mainly on type of project work to be performed. Material planning is done to achieve requirement of project at different phases of construction work and it also reduces excessive wastage of material. Manpower Planning is the process by which an organization ensures that it has the right number and right kind of people, at the right place, at the right time, capable of effectively and efficiently completing those tasks that will help the organization achieve its overall objectives. In any project, most of the activities are done —team-wisely and productivity of individual labour cannot be determined. Also team productivity depends on driving equipment such as grader, roller, paver etc...

The Planning of BRTS Road Project by using Microsoft Project 2007 for 013 KMS and Existing Carriage indicates poor planning of resources. Also equipment assigned for total project is less as compared to required number. From the planning of BRTS highway project after allocating resources to various activities, we come to know if Equipment and manpower is provided as per required data which is analyzed by using Microsoft Project-2007 as compared to actual used on site. It will help to complete project on time with specified duration as per contract.

#### Resource Optimization in Road Construction Projects<sup>[2]</sup>

K sri Bindu, U. Jayasanthosh Kumar

In this paper they studied in highway projects, the same resource is often used for different activities and the productivity of that resource being different for different activities, it becomes inevitable to know the correct norms for correct estimation, planning and monitoring. For the detailed study they taken three cases study and plan their resources by understanding productivity of each of the resource and its use for a particular activity using Microsoft project. They used MSP software for resource planning, scheduling and allocation. In order to optimize the cost and duration in construction projects resource optimization is required. This may be used for the expansion of M.G Road from Patamata to Machilipatnam (NH-9).

The objective of the project was to minimize time and cost by levelling the resources and this was done by taking three cases to compare the optimized results. In Case 1 the entire project was considered to be done in the same order of WBS without breaking it into parts and the cost incurred by the utilization of resources is calculated. In Case 2 the entire project was divided into two parts and the cost incurred by the utilization of resources is calculated. In Case 3 the entire project was divided into three parts and the cost incurred by the utilization of resources is calculated.

Overall they concluded that by scheduling the project in three different types, three different time schedules are obtained and the respective resource allocations are also achieved. From the resource allocations and the time schedule of the three cases the optimal resource utilization is identified by the cost comparison. By performing the resource leveling the cost of the project has been reduced by Rs 9,27,474.72. From the above analysis conducted, the optimal solution is Case 2 with the reduction of cost to Rs 9,27,474.72 where the total cost is Rs 16, 70,59,530.3 which is the least cost of the three cases due to the reduction in duration.

#### Optimization of Resources in Highway Construction<sup>[3]</sup>

Vishnuraj RG, Vishak MS

The project is carried out to have a study about resource Management in highway constructions and its implementation. In recent year's project management software systems like MS Project, Primavera etc. have been improving continuously and recent versions have exhibited better interfaces, integrated planning and control features, and Internet capabilities. Yet, basic project management functions such as resource allocation, resource leveling, and time cost trade-off analysis have been the least improved. The Construction projects, especially the highway construction projects, uses huge amount of resources on and off the field in various forms of resources viz., materials, plants, equipment's and human resources along with money, time and space.. Production and operation sequence management is the process of controlling production and services the main objective of which is to match efforts with application of resources and equipment's in order to best produce and serve. Effort is made to use available resource and time in a desirable way and prevent resource and equipment

waste. Data collection is done by questionnaire survey and it is used to find Benefits of resource management, causes of failure of resource management and causes of resource fluctuation etc.. Project management software primavera is used in order to complete the project on time under budget.

They concluded the visit to highway project site and study of available database in the project site reveals that the construction companies in India have neither yet realize the necessity of detail study of their own resources nor have develop their accounting system for research and development purpose has evident from the lack of useful and relevant data from the site. The present construction practices in India is still adopt the methodology of as and when required,, resource management. Lack of professionalism leading to lack of detailed and meticulous planning and irrational decision making as per site management is concerned leading to underutilization of resources to a great extent. Till now project resource planning is only limited to planning and scheduling with time but resource mobilization and usage planning according to their capacity and availability, ahead of time in the planning stage, is still nobody's concern. Equipment cost for any project comprises of mainly 20-30% of project cost plus additional cost for maintenance, repair and operation. Cost of equipment has to be controlled properly by efficient allocation of equipment for different phases of work. So for using equipment effectively and efficiently equipment becomes necessary. Equipment procurement is done after measuring productivity of every equipment. Material cost for any project which is more or less invariable, it depend mainly on type of project work to be performed. Material planning is done to achieve requirement of project at different phases of construction work and it also reduces excessive wastage of material. Manpower Planning is the process by which an organization ensures that it has the right number and right kind of people, at the right place, at the right time, capable of effectively and efficiently completing those tasks that will help the organization achieve its overall objectives. In any project, most of the activities are done team-wise and productivity of individual labourers cannot be determined. Also teams productivity is depend on driving equipment such as grader, roller, paver etc. From the planning of highway project after allocating resources to various activities,

we come to know if Equipment's and manpower is provided as per required data which is analyze by using Primavera as compare to actual used on site. It will help to complete project on time with specified duration as per contract.

Productivity Escalation and Cost Optimisation of Equipment's used in Pavement Construction<sup>[4]</sup>

Pankaj Suresh Rayamane, Amey A. Kelkar

In this paper they studied cost optimisation of equipment used in pavement construction. The aim of this work is to highlight the importance of Productivity of Equipment's used in Pavement Construction and its Cost. In construction, some tasks are labour-intensive, some pre-dominantly employ equipment and some use a combination of both, i.e., labour and equipment. In big infrastructure projects like Road or Pavement projects, equipment's and the plants play a crucial role in the production process. While the actual work done and the associated labour is accounted for by the foreman concerned, the equipment productivity control is undertaken to determine its employment time, the output achieved and its productivity at the site. The main purpose of equipment productivity control is to minimize the wastage in utilization and to minimize the Costs.

Planning and scheduling is an integral part required for efficient execution of construction activities. Project management software's are trending for helping the manager's for better handling of time and other resources. Microsoft Project is one such software aiding in increasing the overall project efficiency.

In Road Construction, Equipment's play a major role as they manage more than 50 % of the work, so their Costs and Productivity play a major role in making the Project profitable to the company. In this work a Case Study of two Road or Pavement Construction sites is carried out. Efforts are taken to improve the Productivity of Equipment's by using Project Management Techniques which in turn helps to cut down the Costs incurred.

A productivity management of road construction in Thailand<sup>[5]</sup>

Wisoot Jiradamkerng

This research's objectives were to conduct a work study of sub base course of road construction and implement

productivity analysis with EZ Strobe simulation system. The study had divided construction process into 3 parts. Each part of the process was simulated with EZ Strobe to find optimum construction team members with minimum unit cost. These optimum team members were used in simulation model of each part to determine basic time with 95% confident interval and 5% limit of error. Then, the standard time and productivity of each construction team was calculated in various units; production per hour (cu.m./hr., sq.m./hr.), daily production (cu.m./day, sq.m./day, m. of road/day), and number of hour required per section of sub base course construction (200 m. in length). After that, the overall process simulation model including Part1 to Part3 was created, representing for all 26 sections of sub base course construction.

The analysis results showed that optimum team combination of Team1, Team2 and Team3 for the minimum unit cost of sub base construction was 2-1-2; and for the minimum duration of construction was 3-2-3. The outcomes of this research pointed out that, with EZ Strobe simulation system, the productivity management could be done effectively by conducting work study at project site and simulating for alternative resources management plan to determine for optimum construction teams according to the desired project goals.

#### IV AIM & Objectives

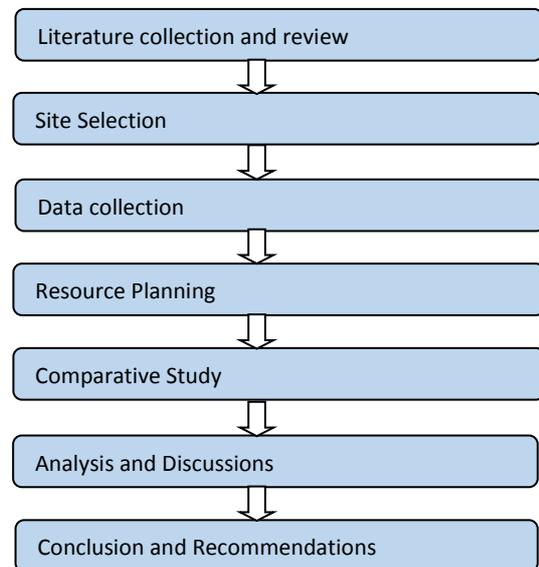
The Main aim of the project is to detailed study of resource planning and productivity can, thus help in good resource planning, better monitoring and overall controlling of the project. In highway projects, the same resource is often used for different activities and the productivity of that resource being different for different activities, it becomes inevitable to know the correct norms for correct estimation, planning and monitoring.

The following objectives are covered is this paper:

1. Studying the different resources required for a highway project.
2. Studying of the productivity resources in different conditions.
3. Finding out the factors controlling the productivity of each of the resources.
4. Comparative study of different resources.

#### V. METHODOLOGY

The main objective of our thesis work was to measure the resource productivity of a highway project; finding out the factors affecting the productivity of the resources; establishing interrelations of the factors and finally formulation of a system to estimate the productivity of the resources in different environmental and site conditions. For this thesis, relevant data was collected from selected highway project sites of Pune-Nashik National highway (NH50) constructing by IRB infrastructure developer's ltd through pre-designed questionnaire and collated for analysis.



**Fig: Flowchart of Methodology**

During the site visits, relevant data regarding the expenses and production rates of different resources used in the sites was collected. After collecting the data, different factors affecting the production rate of those resources was identified and their effects on the production were found out. Collected data were put under a detailed comparative study and analysis of the data collected from various geographically located sites will be used to find out the interrelation among the factors. The factors that are expected to be influencing the equipment production rate are geographical factors like height of construction, topography etc, environmental conditions, materials of construction, nature of activity, operator's efficiency etc. On the other hand, the human resource productivity was likely to be affected by working and living conditions, social-economic factors etc. After the analyses, efforts were put to find the trend of the factors on the productivity

and also build the charts and graphs representing the trends. Finally, a trend of estimating the productivity of a resource in a given particular condition was developed the graphs, charts etc.

## VI. RESOURCE PLANNING

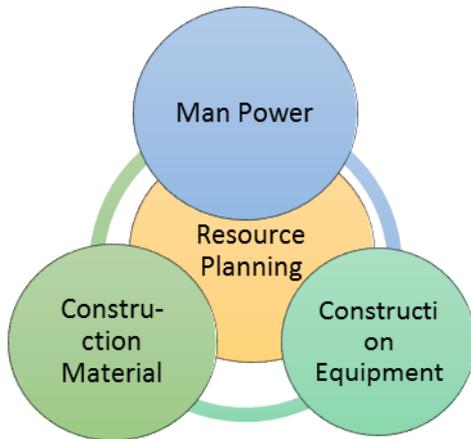


Fig: Main Resource Planning

6.1 Resource planning construction Work force: The project man power planning primarily focuses on determining the size of project work force, it's structuring into functional groups and workers teams, and scheduling the manpower recruitment to match the task requirement.

This process chiefly involves identifying the trades or the skills required, establishing productivity standards to determine the number of worker needed to perform a given job in the specified time, data wise forecasting of workers requirements for accomplishing the project work and finally organizing the planned work force into operating work-teams having assigned programmed tasks.

6.2 Resource planning Construction Materials: Efficient material management in project environments calls for an integrated approach covering numerous functions such as materials planning and programming, materials purchasing, inventory control, store-keeping and ware housing, materials transportation and handling at site, materials codification and standardization and the disposal of surpluses. The material planning and programming, which is the key function on materials management is closely linked with the project planning and control set-up. Both these work together to develop a plan to procurement and stocking of construction materials so as to provide at site, materials of right quantity, at right prices from right source and at the

right time. The construction material planning involves identifying the materials required, estimating quantities, defining specifications, forecasting requirements, locating resources for procurement, getting material samples approved, designing material inventory and developing procurement plan to ensure a smooth flow of materials till the connected construction work are completed at the project site.

6.3 Resource Planning Construction Equipment: Production task needing equipment include excavating, handling, transporting, filling, compacting, grading, hoisting, concreting, pre-casting, plastering, finishing, trenching, and laying of pipes and cables. The supporting equipment at project site consists of generators, transmission lines, pumping sets, other utility services equipment. Construction equipment is indispensable in execution of modern high-cost, time-bound massive construction projects. It produces output with an accelerated speed in a limited time. It saves manpower, which is becoming ever more costly and demanding. It improves productivity, quality and safety and also adds a sense of urgency. Acquisition of equipment mass involves initial heavy investment but, on the whole, its adds to profitability by reducing the overall costs, provided it is properly planned, economically procured and effectively managed.

Equipment planning for a project aims at identifying construction task to be undertaken by mechanical equipment, assessing the equipment required, exploring the equipment procurement options and finally, participating in the decision making for selecting the equipment.

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