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A STUDY TO EVALUATE OF CONSTRUCTION SCHEDULE PERFORMANCE USING ACTIVITY PRODUCTION RATES IN EXPRESSWAY PROJECTS

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ABSTRACT

Improving a country's road network has far-reaching social and economic consequences and is strongly correlated with its competitiveness. But road building is expensive and fraught with social, political, economic, and project-specific hazards that can cause delays and cost overruns. In order to ensure that future initiatives of a similar kind are well-planned and managed, it is crucial to evaluate the discrepancy between the actual and anticipated results. This research compares the actual and anticipated construction performance of the six-lane Mumbai-Nagpur Expressway's principal pavement building activities in Package 14 (Km 623.379 to Km 636.479) using the Linear Scheduling Method. It examines the production rates of these activities. The results show that total productivity efficiency was 90.55%, with a decline from the average anticipated production rate of 651.35 m/day to 588.76 m/day. In order to better allocate resources and plan construction, the results show that the Linear Scheduling Method successfully identifies productivity variances, timetable deviations, and activity-specific bottlenecks.

Keywords: Highway, Production Rate, Construction, Activities, Linear

I. INTRODUCTION

From the perspective of the construction industry, the term "productivity" can refer to a variety of different things depending on the particulars of the situation. This is mostly owing to the fact that this concept has previously been developed in other fields through a number of phases of varying degrees of development. When it comes to describing productivity in the construction industry, the word "labour productivity" is the terms that are most usually used. This is defined as the number of work units that are produced or contributed per man-hour.

One of the biggest obstacles to successful building projects is low productivity, which is especially problematic for emerging nations. The economy benefits from greater productivity as well. Consequently, maintaining focus and increasing output are crucial for a project's completion. But before you can improve productivity, you need a clear and reasonably accurate record of the current productivity rate. This can be achieved by collecting as-built productivity rate data from both finished and ongoing projects. This will allow you to estimate the factors that affect productivity and how they relate to productivity. Then, you can use this information to develop models for future projects that are reasonably accurate in their predictions of productivity rates.

When trying to estimate how long it will take to build the roadway, the most realistic and trustworthy production rates will get close to the truth. In addition to lowering total project costs, a realistic estimate enhances management efficiency, decreases claims and disputes, lessens public traffic disruption, and speeds up project completion.

When it comes to the construction business as a whole, highway construction is massive. These construction operations take place outdoors and are subject to a wide range of operational and environmental factors. Construction sites for highways and factories provide drastically varied working environments. It is well-known that highway construction productivity rates are impacted by several factors, in contrast to the manufacturing business. Factors such as; climate; project type and size; location; site conditions; terrain type; learning curve influence; worksite constraints; crew skills; equipment efficiency and workability condition of materials; competency in supervision; communication between construction parties; change orders; late payments; management (good or bad), and labour organisations.

The efficiency of an activity can be enhanced or diminished by several variables. Nevertheless, schedulers and project managers usually use historical productivity rate charts as their main resource for estimating productivity rates. One major drawback of these methods is that they are subjective and not based on statistics. Another issue is that these estimations can't take into account the relative importance of labour productivity in relation to the specific project characteristics and site circumstances. In most cases, knowing and identifying the factors that influence productivity is the first step in measuring.

II. REVIEW OF LITERATURE

Amede, Ermias. (2020). Highway projects' time and cost estimations are practically affected by the prior calculation of productivity rate. Finding and using the key aspects impacting the productivity rate is directly proportional to the reliability of productivity rate measurement. Consequently, in highway building projects, identifying the important productivity element is of the utmost importance. The purpose of this research is to determine what variables have the most influence on the efficiency of earthwork in highway building projects and to determine how to best mitigate their effects. The study aimed to achieve the stated aims by reviewing extensive literature and using several embedded case studies, taking into consideration that productivity is dynamic and reliant on context. Results from statistical and cross-case analyses showed that the following variables—working hour, weather (temperature, air pressure, and rainfall), and permissible working space or breadth of clearance—had the greatest impact on the productivity rate of soft excavation. The most important variables influencing the rate of productivity in hard excavation, on the other hand, were the kind of terrain, the breadth of clearance, the working hour, and the weather (temperature, cloud cover).

Kannan, S. & Senthil, Ramani. (2014). Due to the inherent unpredictability of construction project durations, road project scheduling has always been a major headache for the industry. Factors including resource availability, environmental circumstances, and location impact the production rates of specific activities, which in turn affect it. The existing method for scheduling road projects relies on the efficiency of a single task performed by a set of assigned workers. This work aims to provide a simple model for predicting the length of road projects using expected production rates of activities, which is useful since these rates are not reached as predicted. A wide range of values was produced by a simulation model that attempted to forecast the probable output rates of these procedures, rendering accurate time calculations unattainable. By taking into consideration factors mainly within the builders' control, the Delphi method yielded a more comprehensive range of production rate estimates. A simple framework for time estimations based on the Linear Scheduling Method (LSM) for scheduling has been proposed in response to the limitations of network techniques in road building. We have simplified the flowchart model of the time estimation approach and included staff definitions, buffer distances, and likely production rates.

Chong, Wai et al., (2011) Highway construction schedule is a critical step in the planning process. The precision of construction scheduling has been the subject of several academic investigations into potential novel approaches. Unfortunately, the requirements of highway designers and the feasibility of the scheduling approaches were neglected in a number of these studies. In order to understand the difficulties designers have when trying to predict highway building output rates, the writers reviewed the literature, administered surveys, and interviewed relevant parties. Our research indicates that production rate estimating methods should be all three: versatile, easy to use, and thorough. Prior to using a production rate tool, data should be obtained from trustworthy sources and analysed in a proper and efficient manner. According to this research, the best approach to create practical production rates for highway construction scheduling is to integrate the knowledge of designers with trustworthy technologies.

Duffy, Gregory et al., (2011). Linear schedules are developed and maintained with precision by activity production rates. There are a lot of factors that influence the rate of output for each activity in linear projects. The goal of this study was to improve linear scheduling's visual skills and extend its capabilities to account for production rate fluctuation when and when it happens. The LSMVPR, a novel linear scheduling model that accounts for variable production rates, aims to accomplish two things. First, along the project's horizontal axis, you should draw up a plan for how to implement modifications to production rates. Another goal is to show how easy or hard the construction is using the time-location chart. This study demonstrated the feasibility of modelling the time- and location-dependent variations in production rates for the purpose of forecasting upcoming building projects. The scheduler may create schedule durations with little project data using LSMVPR, which is based on the idea of working windows. The scheduler can also use the model to examine how different routes or construction start dates will affect the timetable. A new feature called the activity performance index (API) makes it possible for the construction team to see project hurdles in graphical format and when and where they arise.

Colour variation indicates the deviation in projected production rate from the planned production rate; this index is used to shade the linear scheduling chart by time and place.

Jiang, Yi & Wu, Hongbo. (2007) This research was performed to evaluate and revise the productivity of highway building in Indiana. This research acquired highway construction production rates and diverse metrics of production rates to encapsulate the primary characteristics of highway building production. The data encompasses averages, standard deviations, confidence intervals, baseline production rates, and production rates for various probability. The primary elements influencing highway building productivity rates were investigated and their impacts were assessed. The research indicated that production rates were influenced by climatic conditions regarding temperature and seasons, contractors, construction project locations, and highway types.

III. RESEARCH METHODOLOGY

Research Design

The study adopted a quantitative analytical research design.

Study Area

The study was conducted on Package 14 of the Mumbai–Nagpur Expressway, extending from Km 623.379 to Km 636.479, with a total corridor length of 13.10 km.

Sources of Data

The study employed both original and supplementary data sources. Primary data were obtained via daily construction advancement reports, site execution documentation, contractor efficiency logs, project oversight materials, and field assessments. These documents furnished details concerning the true length and advancement attained for every building task. Secondary data were sourced from sanctioned project timelines, design documentation, highway construction standards, MoRTH and IRC directives, technical reports, and earlier scholarly work pertaining to the Linear Scheduling Method and highway project administration. The amalgamation of the two data sources guaranteed the dependability and precision of the productivity assessment.

Construction Activities Considered

The productivity evaluation encompassed seven principal pavement construction tasks that form the entire highway pavement process. The tasks included Site Clearing, Subgrade preparation, Subbase Course installation, Wet Mix Macadam (WMM) application, Bituminous Macadam (BM) laying, Dense Bituminous Macadam (DBM) construction, and Bituminous Concrete (BC) placement. These tasks were chosen due to their repeated characteristics and their direct impact on the overall construction timeline and project completion duration.

Statistical Analysis

The gathered data were examined through descriptive statistical methods to assess production efficacy across various construction tasks. Statistical metrics such as the intended production rate, actual production rate, production variance, productivity discrepancy, productivity efficiency, and mean production rate were computed. The evaluation furnished an extensive appraisal of productivity patterns and facilitated the comparison of the performance of specific building tasks.

IV. DATA ANALYSIS AND INTERPRETATION

Table 1. Planned and Actual Production Rates of Major Pavement Activities

Activity	Total Length (km)	Planned Duration (Days)	Actual Duration (Days)	Planned Production Rate (m/day)	Actual Production Rate (m/day)	Productivity Difference (%)
Site Clearing	13.10	16	18	818.75	727.78	-11.11
Subgrade	13.10	28	31	467.86	422.58	-9.68
Subbase Course	13.10	25	27	524.00	485.19	-7.41

Wet Mix Macadam	13.10	22	24	595.45	545.83	-8.33
Bituminous Macadam	13.10	20	22	655.00	595.45	-9.09
Dense Bituminous Macadam	13.10	18	20	727.78	655.00	-10.00
Bituminous Concrete	13.10	17	19	770.59	689.47	-10.53

Table 1 shows the difference between the expected and actual rates of production for the main highway building tasks. Due to vegetation clearance, utility moving, and sporadic rainfall, the site clearing achieved the maximum initial production rate of about 727.78 m/day. However, this rate was still 11.11% below the projected objective. Because of the need to regulate moisture and conduct repeated field density tests, the subgrade construction rate decreased from 422.58 m/day to 39.68%. Reduced productivity losses of 7.41% in the subbase layer and 8.33% in the Wet Mix Macadam (WMM) layer, respectively, suggest that material transportation and plant operations are efficient. Dependence on asphalt plant production, weather, and traffic management led to increased variances in bituminous activities. The production rates of Bituminous Concrete (689.47 m/day) and Dense Bituminous Macadam (655.00 m/day) were approximately 10% lower than the projected levels.

Table 2. Statistical Analysis of Activity Production Rates

Activity	**Planned Rate (m/day)**	**Actual Rate (m/day)**	**Variance (m/day)**	**Productivity Efficiency (%)**
Site Clearing	818.75	727.78	-90.97	88.89
Subgrade	467.86	422.58	-45.28	90.32

Subbase Course	524.00	485.19	-38.81	92.59
Wet Mix Macadam	595.45	545.83	-49.62	91.67
Bituminous Macadam	655.00	595.45	-59.55	90.91
Dense Bituminous Macadam	727.78	655.00	-72.78	90.00
Bituminous Concrete	770.59	689.47	-81.12	89.47
Average	**651.35**	**588.76**	**-62.59**	**90.55**

There is a statistical summary of the production efficiency-based performance of construction activities in Table 2. An overall productivity efficiency of 90.55% was reached, with the projected production rate being 651.35 m/day and the achieved rate being 588.76 m/day. The most efficient activity was Subbase Course, with a 92.59% efficiency rating. This means that there were fewer interruptions, constant equipment utilisation, and consistent material supply. Site Clearing, on the other hand, had the worst efficiency rate at 88.89%. This is because tasks like clearing land, cutting down trees, and moving utilities are very dependent on the accuracy of the forecasts made for the field.

V. CONCLUSION

The research shows that highway building projects may be better executed with rigorous productivity evaluation. Improved schedule control, more efficient use of resources, and early detection of performance deviations are all outcomes of well-monitored and analysed construction activities. Better project execution, fewer delays, and more operational efficiency are all results of using appropriate planning and scheduling approaches. The results highlight the importance of continuous productivity assessment in ensuring the timely, successful, and sustainable completion of large-scale linear infrastructure projects.

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