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RESOURCE PRODUCTIVITY OF A HIGHWAY PROJECT-CASE STUDY

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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*

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I INTRODUCTION

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 evens the same manpower being used in different activities, a detailed study, categorization and analyses 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. The objective of the project was to minimize time and cost by leveling 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. 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. 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 ads to profitability by reducing the overall costs, provided it is properly planned, economically procured and effectively managed. Productivity means the ability to produce. The term 'productivity', as commonly understood, implies the ratio of output to input. The input and output can be measured in physical quantities, monetary terms or a combination of both. Many link productivity to mean of workers' output capability; they express productivity as work quantity produced per man-hours of input. Productivity is also defined as monitory value of output per man-hour of input. Some consider productivity as performance output in rupees for every rupees of input. In the narrower sense of controlling project resources, the productivity concept is used to measure the performance of resources.

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[1]

K Swarna Kumari, J Vikrant

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 Vishakhapatnam. 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 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 labour cannot be determined. Also teams productivity is depend 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 indicate poor planning of resources. Also equipment assign 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 analyze by using Microsoft Project-2007 as compare 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[2]

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 softwear for resourced 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[3]

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[4]

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[5]

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.

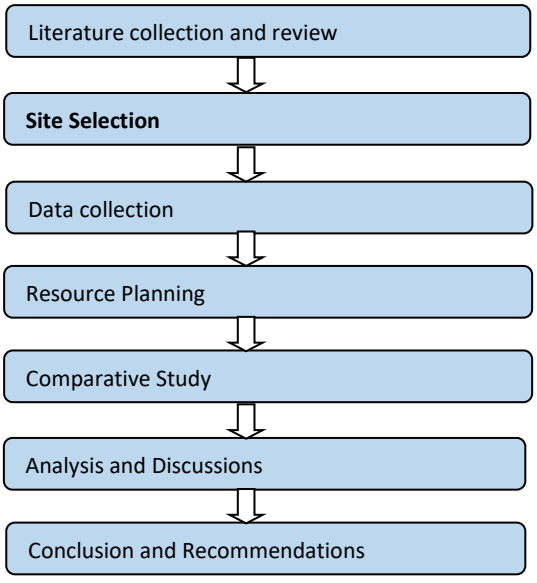
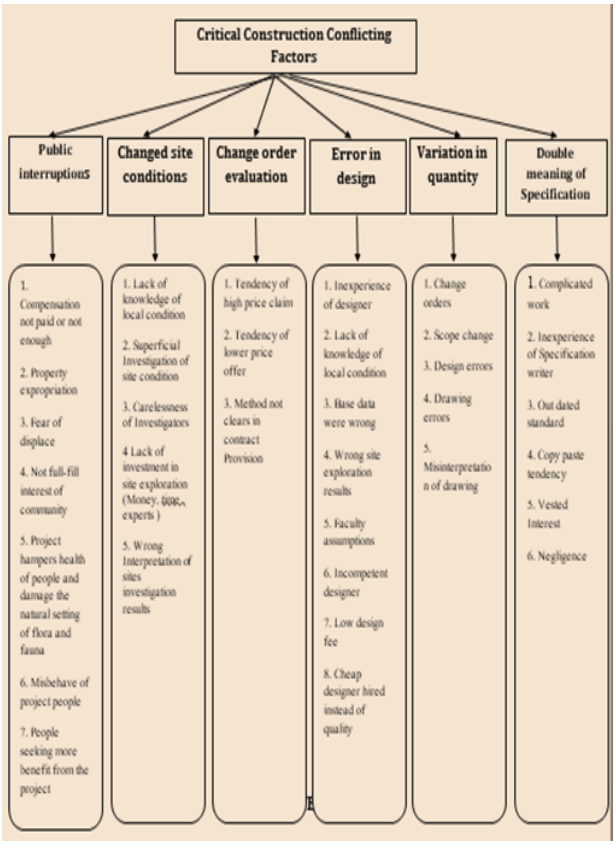


Fig: Flowchart of Methodology

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.



The best dispute management skill is the ability to stay out of dispute not as an avoidance technique but rather, as specific prevention strategy. Three key areas to manage are:

Clear specifications

Writing a specification that will be interpreted the same way by different people is a skill that takes years to acquire. In a dispute, it does not matter what was meant, only what is in the contract.

An independent specification review should find and correct material ambiguities. Unfortunately, most organizations do not conduct such reviews and find out later, after the contract has been put into operation, that the specification should have been much, much clearer.

Clear communication protocols

Internal policies and procedures regarding communication, approvals, signoffs and the like, have no bearing in a dispute unless incorporated into the contract and made an obligation of the parties. Consider the number of people who might have a discussion, some form of correspondence, or even just contact with anyone in the other party – there will be quite a few people acting with presumed authority and inadvertently committing your organization. Have clear internal processes, authorities, forms and the like, incorporate them into the contract and make them binding on both parties.

Proactive issue management

It is not unusual, in a contract of reasonable size and complexity, to have up to 300 unresolved issues at any given time; they can quickly grow into disputes if the environment is right. Before declaring something a dispute, consider managing it as an issue, at least to begin with. Defining a problem an 'issue' rather than a 'dispute' has a big impact. You can apply normal project management techniques to issue management. Have a mechanism for anyone to raise an issue track and assign all issues, and have regular issue resolution meetings.

Attributes:

1	Lack of surveillance
2	Failure of contributors to instantly handle changes
3	variations in legislation and guidelines
4	Lack of understanding
5	Incompetent designer
6	Poor communications among project contributors
7	Lack of cooperation among contributors
8	Indistinct contract documents
9	Impracticable expectations by the parties
10	The impact of local culture.
11	Misinterpretation of contracts
12	Lack of resources
13	Poor communication and documentation
14	Late involvement of lawyers in the construction projects
15	Tendency of lower price offer
16	Working relations and Supervision
17	Circumstances produces a model based on project uncertainty
18	Dispute in construction contracts: Alterations
19	Lack of effective communication among project contributors
20	Delayed payments
21	Design insufficiency
22	Lack of necessary proficiency and experience
23	Poor site management
24	Poor planning and programming
25	Project hampers health of people and damage the natural setting of flora
26	Disputes with subcontractors
27	Late imbursement to subcontractors
28	Harmonization of subcontractors
29	Alterations to standard conditions of contract
30	People seeking more benefit from the project
31	Inappropriate contract type
32	Accident due to moving traffic adjacent to project site
33	Disputes due to discrepancy in contract document
34	Lack of professionalism of participants
35	Weather Conditions
36	Availability of health and safety training
37	Inappropriate in salary, poor wages, Lack of Financial motivations
38	Inaccurate design information and incomplete tender

	Information
39	Inappropriate Contractor Selection
40	Lack of training sessions, lack of labour recognitions programs, lack of place for eating & relaxation, Lack of team spirit
41	Decisiveness of the agreement
42	The location and implementation of work
43	Minimized costs in attaining settlement
44	Sustained business relations
45	Control of the result and procedure

DATA COLLECTION & EXPERIMENTATION

The primary objectives of this field experiment were to

- Determine whether the WRITE system is feasible for measuring construction productivity and
- Identify the advantages and limitations of this system by conducting a case study.

To accomplish the objective, productivity data were collected simultaneously by using the different methods and the WRITE system.

The stopwatch method is a classic productivity measurement method develops. The method uses a stopwatch to record the time spent on each human movement to complete an operation and categorizes each movement as direct work, supportive work, or nonworking. The productivity is computed on the basis of the percentages of direct work, supportive work, and nonworking within certain duration. Results from the stopwatch method and the WRITE system were compared by using statistical methods to determine whether there was a significant difference. Figure shows a data collection form for this project and a sample data set that was used for statistical analysis. The field experiment was conducted at three asphalt paving projects and one bridge reconstruction project. Hot-mix asphalt overlay project and two hot-in-place recycling projects were selected as equipment-intensive projects, and the bridge reconstruction project was deemed to be a labour-intensive project.

Resource productivity as well as labour and capital productivity is indicators that reflect both the development of the economy and the environment. However, the interrelationships between socio-economic and environmental processes are highly complex and available information, judgement of experts and public awareness are often controversial. Therefore, the criterion of policy relevance from this study refers to a reduction of this complexity rather than to a full understanding. In other words, it refers to the capacity of reducing this complexity and providing relevant and useful information for decision making and public discourse.

This scoping study provides evidence that data availability and quality is essential for assessing the impacts of resource productivity on employment.

In recent years, decision makers asked for establishing RMC as the lead indicator for the EU resource efficiency strategy. For this purpose it is important to supplement figures on a country level34. Recently, Eurostat has published the 'Country RME tool' for compiling RME-related estimates at the country level. Since RMC/RME-based estimates at the country level are challenging, calculating RME of product flows at sectoral levels for all EU Member States would be rather difficult. However, examining resource productivity at the sectoral level is of great importance as each sector shows different material use patterns.

A feasible solution might be to focus on some sectors for representative countries. Still, constructing a time series might turn out to be resource and time consuming. Another option includes case studies on individual country experiences which could prove to be useful for other Member States. For example, the construction sector is one of the most important sectors in the European Union. It generates about 10% of GDP and positively influences the growth of employment in other related economic activities. Furthermore, the Netherlands could be an interesting country to study for its high resource productivity in the agricultural and the construction sector.

An already well-established and regularly updated project is the Exiobase36 - a global, detailed Multi-regional Environmentally Extended Supply and Use / Input Output (MR EE SUT/IOT) database. Version 3 will comprise 200 sectors in 44 countries and 5 rests of the world regions. According to involved partners, sectoral data will possibly be available in 2016.

Another approach is to use just direct extraction all over the world data in primarily monetary models and estimate the impact of policies on the extraction in relation to growth and employment effects. Even if this does not explicitly deliver figures for productivity, it reveals the relative effects on labour, capital and resources on regional and global levels, which can be used to further analyze the productivities in question.

In addition, there is a lack of adequately measuring the quality of labour inputs, accounting for skills, gender, education and employment status of the workers. Eurostat, in collaboration with the JRC-IPTS, is currently running a project that aims at improving labour productivity indices by disseminating time series of productivity indicators for Member States. The first dataset will be available in spring for the years to. Data on capital productivity should follow later.

Another way forward would be the development of a more comprehensive econometric analysis that would allow a better understanding of the relationship between potential drivers such as R&D and energy demand. As the examined variables show a significant relationship with resource productivity, going on a sector-by-sector analysis would provide insights as for example to which sectors are receiving more R&D and in which countries R&D is having the most impact on productivity. Accommodating or systematically examining more potential drivers is an integral aspect of a future econometric analysis.

The empirical part of our analysis – as of many other studies - was based on describing correlations rather than the causalities. This is due to the fact that the identification of causal relationships is a difficult task in terms of methodology and goes beyond the scope of this study. Finding causalities was left to the literature review, where we described the results of some comprehensive modelling efforts that show the interlink ages between resource productivity improvements and social, environmental and economic indicators.

In conclusion, the empirical part of this scoping study was not only an exercise to provide a preliminary statistical and empirical analysis of resource, labour and capital productivity, but also to open up possibilities for further investigation, once data will be available. Some topics that could possibly be explored through future analyses comprise:

- Investigation of sectors which would be most affected by job losses due to resource efficiency policies or, in general, the transition towards a more resource efficient economy in the EU
- Analysis of whom within the labour force would be most susceptible to shifts in employment (which skill level, age group).
- Studying of sectors that show high levels of capital investment and whether those sectors are the most/least resource/labour productive. A question to look at is whether labour is being replaced by capital in these most/least resource productive sectors.
- Understanding of the effects of R&D on resource productivity on a sector level, comparing between Member States and establishing reasons for differences, if there are some

DATA ANALYSIS & EXPERIMENTATION

The questionnaire were distributed over large construction as well as small construction projects including the group of workers including site engineers, Painter, steel binder, Plasterer, Meson Brickwork, Carpenter, Gardener for Landscaping and many more. One of the most important stages was to collect accurate data, the total number of questionnaires sent was and the number of responses received and validated. This figure is greater than the required sample size, so the data obtained satisfies the quality requirements. The results of the survey were synthesized by the author and evaluated the impact, which are divided into seven groups of factors affecting the labour productivity of construction workers on sites in as follows.

Ranking of factors on workers themselves

Factors	RII	Impact	Ranking
Experience of workers	4.29	Very high	5
Labour Discipline	4.12	Very high	5
Physical ability	4.01	High	4
Psychophysiology ability	3.78	High	4
Labour Intensity	3.52	Mid	3
Age	3.41	Low	2
Gender	3.19	Extreme Low	1
Level of training	3.09	Extreme Low	1

The lower the labour intensity, the lower the labour productivity, the physiological psychological problems of people will affect the efficiency of work thus affecting the labour productivity. The higher the age, the more accumulated experience, but the physical strength can be reduced, thus greatly affecting labour productivity.

Ranking of operational and managerial factors

Factors	RII	Impact	Rank
Ability to organize Production	4.23	Very high	5
Construction supervision	4.20	High	4
Application of technology	3.92	Mid	3
Workers' arrangement	3.73	Low	2
Labours Communication	2.89	Extreme low	1

Ranking of factors that motivate employees

Factors	RII	Impact	Ranking
Types of salary payment	4.27	Very high	5
Staff Support	4.05	High	4
Reward Mechanism	3.69	High	4
Spiritual Life	3.58	Mid	3
Training and improving skills	3.32	Low	2
Initiative at work	3.18	Extreme low	1

Professional training, skills upgrading and innovations in labour are factors that have high impact on labour productivity. These factors directly influence the motivation of employees, bring satisfaction and sense of responsibility of construction workers to the work

Factors	RII	Impact	Ranking
Quality of materials	4.25	Very High	5
Quality of working tools	4.01	High	4
Complexity of works	3.72	Low	2
Material transport methods	3.02	Extreme Low	1

Ranking of factors of working tools and object

High-impact factor is the complexity of the work with RII = 3.78 and factor of material transport methods with RII = 3.22. These factors affect the performance of the work that will also affect labour productivity as reported. In order to ensure the achievement and growth of labour productivity, organizations need to utilize machines, equipment and tools which must be suitable with products and technologies; ensure routine readiness and operation throughout the working shift; ensure raw materials, semi-finished products putting into production must have evident origin and qualification.

Ranking of natural environmental factors

Factors	RII	Impact	Ranking
Weather conditions	4.82	Very High	5
Regulations,	3.42	High	4
Geological and	3.27	Mid	3
hydrological conditions	3.12	Low	2
laws on construction	3.02	Extreme Low	1

Weather factor is a factor that has a high impact on labour productivity and is ranked first with RII of 3.82. Most construction works are built in natural spaces, where are affected directly by the weather. The weather not supporting or sometimes becoming severe has a not small impact on labour productivity. The role of natural conditions for labour productivity is objective and unavoidable. Therefore, to ensure the achievement and increase productivity, construction firms need to anticipate the difficulties arising due to natural environment conditions to mitigate risks in the production process. The second most influential factor is the factor of regulations on construction with RII = 3.42. Regulations and national policies that influence the goals and direction of the production of the construction firms, affecting the organizational policies for workers on wages, investment in science and technology, so on, thus affecting productivity.

TESTING RESULTS & DISCUSSION

Experimental Determination of material properties

Various tests will be carried out on the materials used in Waste tyre rubber bitumen. The following tests will be carried out on materials:

1) Bitumen with Partial Replacement with Waste Plastic
- Standard Penetration Test [IS: 73 (1950-62-92)]
- Softening Point Test [IS: 73 (1950-62-92)]
- Ductility Test [IS: 73 (1950-62-92)]
- Stripping Value Test [IS: 73 (1950-62-92)]
- Marshall Stability Test [IS: 73 (1950-62-92)] (For bituminous mix containing both Waste plastic and Reclaimed Asphalt Pavement)

2) Fine Aggregate and Coarse Aggregate with Partial Replacement of Reclaimed Asphalt Pavement
- Flakiness Index [IS 2386]
- Elongation Index [IS 2386]
- Impact Value [IS 2386]
- Sieve size analysis [IS 2386]
- Specific Gravity [IS 2386]
- Water Absorption Test (%) [IS 2386]

These all testing will be done for all the design mix to determine the mechanical properties and durability of the specimens and Results will be find out for all the tests of all design mix and it will be compare.

Properties of Bitumen

Properties	Bitumen Grade 60/70
Penetration	63
Softening Point	62 C
Ductility	64.5mm

1.For various Tests for Bitumen Replaced by Waste Plastic

Waste Plastic in Percentage of Weight of bitumen	0%	5%	10%	15%	20%	25%	Total No. of Samples
Standard Penetration Test	1	1	1	1	1	1	5
Softening Point Test	1	1	1	1	1	1	5
Ductility Test	1	1	1	1	1	1	5

2.For various Tests for NA Replaced by Reclaimed Asphalt Pavement

Weight of RAP in percentage of weight of Natural aggregate	0%	10%	20%	30%	40%	50%	Total No. of Samples
Flakiness and Elongation Index	1	1	1	1	1	1	5
Sieve Analysis	1	1	1	1	1	1	5
Specific Gravity	1	1	1	1	1	1	5
Water Absorption Test	1	1	1	1	1	1	5
Impact Value Test	1	1	1	1	1	1	5
Crushing Value Test	1	1	1	1	1	1	5

3. For Marshall Stability Test

Waste Plastic	0%	5%	10%	15%	20%	25%
RAP	No. of Samples					
0%	3	3	3	3	3	3
10%	3	3	3	3	3	3
20%	3	3	3	3	3	3
30%	3	3	3	3	3	3
40%	3	3	3	3	3	3
50%	3	3	3	3	3	3

(Plastic Content , RAP Content)(%)	Wt. of Sample		Bulk Sp. Gr. Of Sample	VMA (%)	VFB (%)	Viscosity grade		Modified Bitumen – Hot Climate		Modified Bitumen – Cold Climate		Marshall stability (KN)
	Air (gm.)	Water (gm.)				Avg MS	Avg Flow	Avg MS	Avg Flow	Avg MS	Avg Flow	
(0,0)	1201.7	755.9	3.46	12.86	63.92	3.29	3.59	22.1	3.28	18.6	5.4	11.67
(0,10)	1273.8	776.3	2.63	12.76	59.44	3.58	3.19	20.1	3.48	16.5	5.1	11.22
(0,20)	1273.7	741.8	2.34	10.81	59.04	2.56	2.82	16.8	3.28	10.9	4.7	10.54
(00,30)	1281.6	726.6	2.89	7.25	58.83	3.96	3.30	18.8	4.40	12.3	5.2	10.01
(0,40)	1260.0	708.4	2.71	6.69	57.57	2.42	2.99	13.6	3.58	13.1	3.9	9.85
(0,50)	1209.1	753.0	3.17	6.11	57.45	3.51	2.51	23.8	3.72	17.4	3.9	9.57

Observation Table & Test Results:

Test Results & Minimum Requirements For Paving Grades (IS 73: 2013)

Sr.No	Name of the test	Test results	VG 10	VG 20	VG 30	VG 40	Test Method
1	Specific Gravity	"--"	-	-	-	-	IS 1202- 1978
2	Penetration at 25 Deg C in 1/10 of mm	53	80	60	45	35	IS 1203- 1978
3	Absolute viscosity at 60 Deg C in Poises	"--"	800-1200	1600-2400	2400-3600	3200-4800	IS 1206 (P2)
4	Kinematic viscosity at 135 Deg C in cSt	"--"	250	300	350	400	IS 1206 (P3)
5	*Flash Point (Cleveland open cup) in Deg C	"--"	220	220	220	220	IS 1448 Part 69
6	Softening point(R & B) in Deg C	47	40	45	47	50	IS 1205 -1978
7	Ductility at 25 Deg C in cm	100	75	50	40	25	IS 1208- 1978
8	*Loss on heating in percentage	"--"	-	-	-	-	IS 1212-1978

Observation Table & Test Results:

Sieve Analysis of Fine Aggregate as per IS2386, P-1 2016			Percentage passing as per IS 383-2016			
Sr. No.	Sieve Size -mm	Percentage passing- %	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
1	10	100.0	100	100	100	100
2	4.75	98.8	90-100	90-100	90-100	95-100
3	2.36	88.1	60-95	75-100	85-100	95-100
4	1.18	51.7	30-70	55-90	75-100	90-100
5	0.6	34.5	15-34	35-59	60-79	80-100
6	0.3	25.7	5-20	8-30	12-40	15-50
7	0.15	18.2	0-10	0-10	0-10	0-15
Fineness Modulus - %		2.83				
Sand Confirming as per clause no. 4.3 of IS 383-2016		"I"				

Test Particular	Unit	Test results	Test Method	Specified limit
Specific Gravity	-	2.64	IS 2386 P3 - 2016	-
Water absorption	%	3.48	IS 2386 P3 - 2016	-

Observation Table & Test Results:

Sieve analysis of coarse aggregate and specified percentage passing as per IS-383:1970 (RA) 2016

Sr.No	Sieve Size in mm	Percent Passing	10mm-Single Size	20mm-Single size	20mm-Graded size	40mm -Single size	40mm Graded size
1	40	100.0	-	100	100	85-100	95-100
2	25	100.0	-	-	-	-	-
3	20	98.8	-	85-100	95-100	0-20	30-70
4	16	48.1	-	-	-	-	-
5	12.5	8.9	100	-	-	-	-
6	10	0.6	85-100	0-20	25-55	0-5	10-35
7	4.75	0.0	0-20	0-5	0-10	-	0-5
8	2.36	0.0	0-5	-	-	-	-

Test Particular	Unit	Test Result	Test method	Specified Limit
Sp. Gravity	-	2.9	IS 2386 P: 3-2016	-
Water Absorption	%	0.99	IS 2386 P: 3-2016	-
Aggragate Crushing value	%	16.96	IS 2386 P 4 - 2016	Max 45% Non wearing surface Max. 30% - Wearing surface
Flakiness Index	%	3.52	IS 2386 P1:2016	-
Elongation Index	%	3.47	IS 2386 P 1-2016	-
Aggregate Impact value	%	15.03	IS 2386 P 4 -2016	Max 45% Non wearing surface Max. 30% - Wearing surface

CASE STUDY:

SOLAPUR – DHULE ROAD PROJECT

4-Laning of Solapur-Dhule 211 (New NH-52) from 00.000 KM to 453.000 KM in the state of Maharashtra to be executed as BOT (Toll) on DBFOT Pattern under NHDP.

This route is one of the major high density traffic highways in India. Poor existing pavement condition, unhealthy condition of several cross drainage structures and increasing traffic volume levels on this road indicated an urgent need to improve and augment the capacity of the road Infrastructure.

The project consists of up gradation and strengthening of the existing 2 lane carriageway and widening the same to 4 lane dual carriageway, improving and rehabilitation or reconstruction of cross drainage structures between Solapur-Dhule sections of NH-211. The project is being done through Public Private Participation (PPP) on Build Operate Transfer (BOT) basis. The concessionaire/Operator's scope include Designing, Constructing, Maintaining and Operating the project corridor for a period of 29 years and then will transfer the project operations in hands of NHAI.

SALIENT FEATURES:

Name of Project	"Four Laning of Solapur to Yedeshi Section of NH-211 from Km 0.000 to Km 100.000 (Design Length - 98.717 Km) in the State of Maharashtra to be executed as BOT (Toll) on DBFOT Pattern under NHDP Phase - IV"
Total Length of Project	98.717 Km
Contract / Phase	Phase NHDP Phase – IV
Client / Authority	National Highways Authority of India. (Ministry of Shipping, Road Transport & Highways).
Concessionaire	M/s. Solapur Yedeshi Toll way Private Limited
Independent Engineer	M/s. SA Infrastructure Consultants Pvt. Ltd. In Association with Dhruv Consultancy Services Pvt.Ltd.
Project Management Assistant	M/s. Sowil Limited
EPC Contractor	M/s. IRB / MRM Pvt. Ltd. Design
Consultant	M/s. STUP Consultants Private Limited
Bankers	IDBI Bank
Total Project Cost	INR 972.50 Crore.
Date of Signing of Concession Agreement	03rd March 2014
Appointed date	21st January 2015
Scheduled Four-Laning Date	910th (nine hundred and tenth) day from the Appointed date (18.07.2017).
Concession Period	29 Years Commencing from the Appointed Date.

SITE PHOTOS:

SR.NO.	TYPES OF STRUCTURES	NO. OF STRUCTURES
1	Major Bridges	2
2	Minor Bridges	24
3	ROB	1
4	Pipe Culverts	115
5	Slab Culverts/Box Culverts	6
6	Vehicular Overpasses	1
7	Vehicular and Non-Vehicular Underpasses	1

Following are the Proposed Structures in the Project Site:

SR.NO.	TYPES OF STRUCTURES	No. of Struct.
1	Major Bridges	2
2	Minor Bridges	25
3	ROB	1
4	Flyover / Vehicular Underpasses	7
5	Pedestrian / Cattle Underpasses	11
6	Box Culverts	11
7	Pipe Culverts	123

VI CONCLUSION

The economic impacts of highway infrastructure; this suggests that recent empirical evidence can help reconcile the divergent views on the role of highways in the economy. The resolution illuminates two ideas that should be more prominent in transportation policy. First, highways are associated with both local economic gains and economic losses. In a system of centralized highway finance, this creates the possibility of a geographic mismatch between the areas that pay for highway projects and the areas that benefit from those projects. Second, efficiently using the available highway capital is potentially as effective as building additional highway stock in enhancing the local economic impacts of highways. Both ideas suggest the need for more decentralized, project-specific highway finance that includes a role for efficient pricing. The policy implications of a more decentralized highway finance system are discussed in the closing section of the article.

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