

# International Journal of Innovative Research in Science, Engineering and Technology

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## Detailed Study on Heavy Equipments with Its Latest Technologies for Pune Metro Projects

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**ABSTRACT:** Tremendous increase in the numbers of vehicle in roads causing delay in road transportation due to traffic, but with the introduction of Metro Rail a huge number of passenger can travel in a much shorter time and also its very economical as compare to the travelling cost through private vehicle. To prepare this report first of all questionnaire survey and details regarding equipment was been collected from various construction site then it was converted in the form of Binary Variable for Cluster Analysis. The Cluster Analysis was carried out for groups of equipment that are similar to each other but different from individuals. Which helps to realize the similarity as well as dissimilarity of the equipment as well as the advancement of the technologies for performing work? While compile this report the number of accident occurred while the execution of Metro Project was also considered. The report consists of brief study of matches, similarity and dissimilarity of the equipment.

**KEYWORDS:** Metro Rail, Construction, Heavy Equipment, Performance, Material Handling, Cluster Analysis.

### I. INTRODUCTION

Pune is well known as the 'Queen of Deccan' due to its scenic beauty and rich natural resources. Besides, it is famous for its religious and historical places. Pune city is known in the world map because of its educational, research and development institutions. The district also has an importance as an important military base. Pune is the most industrialized district in western Maharashtra and a famous IT hub in the country. Pune exemplifies an indigenous Marathi culture and ethos, in which education, arts & crafts and theaters are given due prominence. Pune is the cultural capital of Maharashtra. The importance of infrastructure for sustained economic development is well recognized. High transaction costs arising from inadequate and inefficient infrastructure can prevent the economy from realizing its full growth potential regardless of the progress on other fronts. Physical infrastructure covering transportation, power and communication through its backward and forward linkages facilitates growth, social infrastructure including water supply, sanitation, sewage disposal, education and health, which are in the nature of primary services and has a direct impact on the quality of life. The performance of infrastructure is largely a reflection of the performance of the economy. The preparation of detailed project report (DPR) work was undertaken by the Delhi Metro Rail Corporation and they submitted their report on 15 August 2008. In 2010, the Pune Municipal Corporation (PMC) delayed submitting the proposal to the Union government to make provisions in the annual budget for the project. Due to red tape and bureaucracy, the DPR was approved by the Maharashtra government only on 12 June 2012. Pune Metro Rail Corporation (PMRC), a special purpose vehicle (SPV) to execute for the project, will be formed.

#### A. OBJECTIVES

The main objective of this project is to study about the latest advancement of the technologies, the problems and issues related to the equipment used.

1. Study and Measure the productivity aspects at PUNE metro rail.

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2. Provide Suggestions to increase productivity of the same.
3. To identify and analyze the various risks i.e. present and the future risks which may occur during the project construction and maintenance.
4. To prepare and recommend a checklist for identification of risks and their mitigation measures in the project under consideration.

## B. NEED AND SCOPE OF METRO

Public Transport System is an efficient user of space and with reduced level of air and noise pollution. As the population of a city grows, share of public transport, whether road or rail based, should increase. Experience has shown that, in cities like Pune where roads do not have adequate width and which cater to mixed traffic conditions comprising slow and fast moving vehicles, road transport can optimally carry 8,000 persons per hour per direction (phpdt). When traffic density increases beyond this level, average speed of vehicles comes down, journey time increases, air pollution goes up and commuters are put to increased level, of inconvenience. Thus when on a corridor, traffic density during peak hours crosses this figure, provision of rail-based mass transport

## II. LITERATURE SURVEY

In spite of the development in construction industry; the productivity in this sector is still considered as critical factor for most construction firms. This paper reviews current productivity measurement literature, particularly that pertaining to the construction sites, and offers recommendations/suggestions, for improvement of productivity at the site. It also shows the productivity of a concrete boom placer based on its planned/targeted concrete vis-a-vie actual consumption, wherein targeted machine hours are the input value and actual machine hours is the output of the productivity. Considering single factor type of productivity i.e. amount of concreting done, calculations of the productivity of the boom placer in Hyderabad metro rail project is made. This paper explains, why productivity at construction site is reduced due to improper shuttering, and unavailability of materials. [1]

Large numbers of construction equipment are required on construction site. The efforts of contractors are to constantly push machine capabilities forward. As the array of useful equipment expand, the importance of careful planning and execution of construction equipment's increases. The objective of the project is to predict the fleet production rate and to optimize the number and size of equipment's in the fleet to match the equipment to project situations. Equipment economics is taken into consideration for the optimization. [2]

At present, urban metro construction accidents occurred frequently in China are accompanying with the rapid growth of metropolis and infrastructure investment. Clear quality control during urban metro construction has become extremely important but is very difficult, time-consuming and chaotic due to the lack of product parameters, clear organization and process information. This paper presents the development and application of a CIC-based system for quality risk early warning in urban metro construction.[3]

Throughout this paper, we tried to discuss the overview of construction sector in Indian economy. Construction starts with planning, design, and financing and continues until the structure is ready for occupancy. The Construction industry of India is an important indicator of the development as it creates investment opportunities across various related sectors. The industry is fragmented, with a handful of major companies involved in the construction activities across all segments; medium sized companies specializing in niche activities; and small and medium contractors who work on the subcontractor basis and carry out the work in the field. [4]

After the proposed Green Construction Policy is adopted by the LACMTA Board, staffwill incorporate the requirements of this policy in all future procurement contracts. It isnot retroactive. Staff will encourage Contractors that work on existing constructionprojects in LACMTA properties or rights-of-way to implement the provisions of

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this policy to the greatest extent feasible. Staff will develop a collaborative process to phase the implementation of this policy in other jurisdictions that receive/program LACMTA funding (in whole or in part) for construction projects. [6]

Based on the international vulgate safety risk managing theory, the Guangzhou Metro Corporation (GMC) summarizes the standard system of safety risk management in metro rail transit project, integrating with criterion files about project on safety risk management promulgated by the Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD), according to the project practice. The result of application indicated that this system, which has been popularized in several other Chinese cities, effectively guaranteed personnel and project safety, and promoted the safety risk managing level of project participators in the same time. [7]

Organization structure and projected staffing numbers will be developed for all tasks associated with the operations, maintenance, security, safety and Agency oversight of the CP/EV LRT Project. A preliminary organization and staffing table was developed and is included in the Preliminary Industrial Engineering Report for the Maintenance and Storage Facility. As currently envisioned, three Contract Operator will be hired and will be responsible for all daily operations functions including maintenance and service of the following system elements. [8]

The objective of this paper is to present a pre-feasibility study conducted by carrying out household surveys and focusing on the short-comings of the Pune metro (India) to be faced in near future based on the available data and providing suggestions for the afore-mentioned problems. Construction, geological and the cost factors have also been considered in the paper. The proposals given can serve as a reference to avoid the future infrastructure conflicts and planned development for the Pune metro department. [9]

Tremendous increase in the numbers of vehicle inroads causing delay in road transportation due to traffic, but with the introduction of Metro Rail a huge number of passenger can travel in a much shorter time and also its very economical as compare to the travelling cost through private vehicle. To prepare this report first of all questionnaire survey and details regarding equipment was been collected from various construction site then it was converted in the form of Binary Variable for Cluster Analysis. [10]

### III. METHODOLOGY OF WORK AND RESULT ANALYSIS

First of all literature review was done then metro construction site where been visited and few data was collected. Then a list of equipment was made and data were collected for them which was converted as binary variable for analyzing the data and after that it was discussed at last.

List of few equipment used while execution of metro project.

1. Earth-moving equipment
2. Hoisting equipment
3. Hauling equipment
4. Earth-compacting equipment
5. Bar bending equipment
6. Transportation equipment
7. Lifting equipment

In the present scenario precast concrete methods are used while performing metro construction and the widely used heavy equipment for execution of metro projects are excavator and cranes. So these two equipment were mentioned in my report, as there are lots of different models of Excavator are available in market. So the data were collected for different models of excavator and also for Gantry Crane and mobile crane.

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## CLUSTER ANALYSIS

Cluster analysis is the task of grouping a set of objects in such a way that objects in the same group are more similar to each other than to those in other groups. With the help of cluster analysis the dissimilarity, Similarity Measure for Asymmetric Binary Variables and the match between the different models of equipment can be found.

### 1) Binary Variables

This Analysis was done to find the dissimilarity between the different models of equipment.

A contingency table for binary data:

		Object j		
		1	0	sum
Object i	1	a	b	a + b
	0	c	d	c + d
sum		a + c	b + d	p

(Distance measure for asymmetric binary variables)

$$d(i, j) = \frac{b+c}{a+b+c}$$

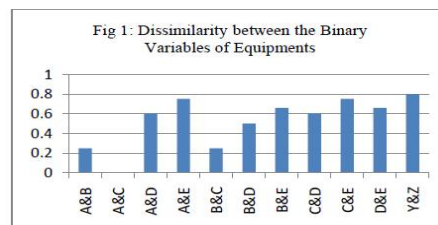
Table 1: Each variable of excavator is mapped to a bitmap(binary vector)

Type	Classification	Avg. Fuel Consumption	Power Output	Capacity	Maint. Required
A	1	1	1	0	1
B	1	1	0	0	1
C	1	1	1	0	1
D	1	0	0	1	1
E	1	0	0	0	0

Table 2: Each variable crane is mapped to a bitmap (binary vector)

Dissimilarity between Binary Variables of Excavators A&B = 0.25, A&C = 0, A&D = 0.6, A&E = 0.75, B&C = 0.25, B&D = 0.5, B&E = 0.66, C&D = 0.6, C&E = 0.75, D&E = 0.66

Dissimilarity between Binary Variables of crane Y&Z = 0.8



### 2) Categorical Variables

This Analysis was done to find the match between the different models of equipment

$$d(i, j) = \frac{p-m}{p}$$

The matches between the excavators A&B = 3.75, A&C = 5, A&D = 2, A&E = 1.25, B&C = 3.75, B&D = 2.5, B&E = 1.7, C&D = 2, C&E = 1.25, D&E = 1.7

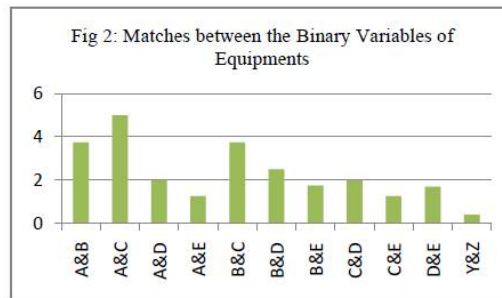
The matches between the crane Y&Z = 0.4

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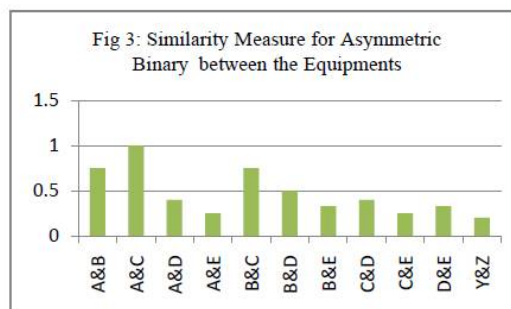


### 3) Jaccard Coefficient

This Analysis was done to find the Similarity Measure for Asymmetric Binary Variables

The Similarity Measure for Asymmetric Binary Variables Excavator A & B = 0.75, A&C = 1, A&D = 0.4, A&E = 0.25, B&C = 0.75, B&D = 0.5, B&E = 0.33, C&D = 0.4, C&E = 0.25,

D&E = 0.33 The Similarity Measure for Asymmetric Binary Variables Excavator Y&Z = 0.2



## IV. LIST OF FEW EQUIPMENT USED WHILE EXECUTION OF METRO PROJECT

### 1. Earth Moving Equipments

Earth moving equipment is one of the most important heavy machinery that is used in construction businesses. The basic function of these machines is to remove sand, wood, rocks, demolition debris and other unwanted elements from the site of construction and dump it onto some other machinery, which then carries it off. These equipments have wheels or tracks on which they move. The earthmoving equipment market in India is estimated at about US\$ 1.4 billion. The predominant sub-segment in this is excavators, which account for just over half the market. Backhoes account for 26 per cent and loaders for another 5 per cent share. The prime driver for earthmoving equipment is mining activities and construction industry. Within these industries, the key demand drivers going forward are likely to be road construction, urban infrastructure, irrigation, real estate. Construction and mining

**Heavy wheel loaders-** the range of loaders that we supply is wide and includes L&T Komatsu PC 200-6, Kawasaki 95ZV-2, John Deere 844K, Volvo L120E, Case 921E and Caterpillar 950H. Compact track loaders and multi terrain loaders are the two main types of loaders that we work with. The power range that these machines use extends from 42 kW to 61 kW. The type of machine you choose depends upon the area in which you are working.

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**Hydraulic Excavators**- excavators are also called diggers or shovels. These machines are used for digging trenches and foundations, demolitions, landscaping, and mining projects. Excavators can come in four sizes- mini, small, medium and large.



## 2. Lifting equipment:

Bearing heavy weights is something that you must do only with reliable equipment. The cranes and other lifting equipments that we provide on rent are: Cranes (from 10 to 1000 tonnes) Tower Cranes Hoists Winches All heavy lifting tools, tackles and spares Constructing a structure in and around water bodies is not easy. Contact us for the following floating equipments:

1. Constructing a structure in and around water body
2. Jack Up Platforms
3. Grab Dredgers
4. Submersible Dock Barge
5. Hydro clam Barge
6. Multipurpose Hopper Barge
7. Lifting Assembling Barge
8. Tug
9. Drilling & Blasting pontoons
10. Cutter Suction Dredger

We also supply Construction Work Support Equipments, like Compressors Emergency Diesel Generator Sets, Temporary Lighting (with circuits and local MCB boards), Start-up transformers, Tremmy pipes, Compactors, Welding sets (electrical and diesel driven), Filling Pumps, Dewatering Pumps, Booster Pumps, Diesel Pumps, X Ray Machine with crawler, Mobile lab testing vehicles, Submersible Pumps, Caravans, Blasting Gun, Spray Guns, Elcometer, Distomat, Theodolite, Infrared Testers, Ultrasonic Concrete Testers

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### 3. Hoisting equipment:

One of the largest advantages of a hydraulic engine hoist are wide variety of places the tool can be used. When talking about manual and electric chain hoists, they require special installations or scaffolds, so a hoist hangs over the small equipment. Construction such a system often costs a lot more than purchasing a hydraulic hoist and sometimes isn't even possible to build, if, for example, you have limited space in your workshop.



### 4. Bar bending equipment

1. When Bar bending schedule is available, cutting and bending of reinforcement can be done at factory and transported to site. This increases faster execution at site and reduces construction time and cost due to less requirement of workers for bar bending. Bar bending also avoids the wastage of steel reinforcement (5 to 10%) and thus saves project cost.
2. It improves the quality control at site as reinforcement is provided as per bar bending schedule which is prepared using the provisions of respective detailing standard codes.
3. It provides the better estimation of reinforcement steel requirement for each and every structural member which can be used to compute overall reinforcement requirement for entire project.

Pipe Bending Machine



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## VI. FIELD APPLICATIONS

### Application of Metro System:

1. Requires 1/5th energy per passenger km compared to road-based system.
2. Causes no air pollution in the city.
3. Causes lesser noise level
4. Carries same amount of traffic as 5 lanes of bus traffic or 12 lanes of private motor cars (either way) if it is a light capacity system.
5. Is more reliable, comfortable and safer than road based system
6. Reduces journey time by anything between 50% and 75% depending on road conditions.
7. Quality improvement-Among the most significant criteria for evaluating a construction equipment company's performance is the reliability and quality of the construction. Using construction and earth moving equipment in complex and heavy construction activities significantly improves both these measures. Employing earth moving equipment as opposed to manual labour allows contractors to complete work with minimal quality defects, shielding them from claims arising from poor workmanship.
8. Project efficiency- Earth moving equipment overcomes many of the limitations associated with manual labour, from its inconsistency—due to weather, attendance, health, socio-economic conditions and a variety of other factors—to the time it takes to complete projects. In fact, usage of earth moving equipment can reduce a project's completion time significantly.
9. Cost savings and profitability- Increased productivity and the reliability of earth moving equipment ultimately translate into higher profitability from fewer defect-related claims and the avoidance of delay penalties. In addition, using earth moving equipment can significantly reduce the cost of large-scale projects. It also makes it easier for the companies to complete their projects within budget at a reduced overall cost.
10. Safety- Any construction site is the locus of multiple high-risk activities. There are obvious safety concerns associated with workers operating on the ground, particularly within confined spaces when heavy materials are being moved around. Using earth moving equipment for construction activities helps mitigate or even prevent many of these risks.

## VII. DATA COLLECTION FROM FIELD

### A. Phase I

1. The two routes that have been identified for the first phase are:
2. Vanaz – Ramwadi, via Deccan Gymkhana, Yerwada (14.9 km, elevated)
3. Chinchwad – Pimpri – Swargate, via Agriculture college (16.5 km, elevated/underground from Range Hills)

### B. Phase II

1. The second phase of the project will contain two lines and the extension of first phase:
2. ASI to Hinjawadi via Aundh (18 km elevated)
3. Deccan Gymkhana to Bund Garden Via Swargate and Race Course (11 km underground)
4. Extension of lines from Pimpri-Chinchwad to Nigdi and Swargate to Katraj (11.5 km elevated)
5. Extension of lines from Aundh to Hinjawadi and Ramwadi to Kharadi Naka (13 km elevated)
6. Extension of lines from Ramwadi to Viman Nagar Airport (elevated)

### C. Secondary data from RITES (1998) and CES (2004) studies

The present study utilizes the data pertaining to planning variables, transportation system, etc. as collected during previous studies conducted by RITES (1998) and CES (2004). The Transportation system data such as the highway and



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public transport networks and systemParameters, however, have been updated thoroughly in the present study with the help ofGoogle imagery and some amount of ground verification.

## D. Stated Preference (SP) Survey

Stated Preference (SP) is a statement by an individual of his/her liking (or disliking) for oneAlternative over another. The stated preference technique is used to determine thecommuter behavior with respect to the improved transportation system. In this study, theSP study was used to know commuter's preference and willingness to shift to the proposedMetro rail System. The survey was conducted at workplaces in the potential areas likeShivajinagar, Chinchwad, etc. The workplaces included PMC office, PCMC Office, Tata Motors,Shoppers Stop, ICC trade towers, etc.

## E. Traffic Volume counts

In order to establish the base year travel pattern in the study area, in all the traffic volumeSurveys were undertaken at 20 locations across the 2 screen lines and 14 locations on theCordon line. Cordon stations were established at all those points where the external roadLinks cross the cordon line entering the study area. The details of the location of screen lineStations are provided in Table 2.9 and those of cordon stations are provided in Table 2.10.The data sheets used for traffic volume surveys, O-D surveys and occupancy counts areProvided in the traffic report.

## VIII. CONCLUSION

Pune has witnessed enormous industrial growth during the last 10 years. Rapid urbanization in the recent past has put the city's travel infrastructure to stress. Being thickly populated area, Pune's traffic needs cannot be met by only road-based system.Studies have brought out that a Light Metro with carrying capacity of about 25,000 phpdtd will be adequate to meet not only the traffic needs for the present but for the future 30 to 40 years also A Light Metro System consisting of two Corridors namely (i) PCMC – Swargate Corridor (16.59 km) and Vanaz - Ramvadi Corridor (14.93 km) at an estimated completion cost of Rs. 10869.00crores (Central taxes & duties) to be made operational has accordingly been recommended

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