

# Detailed Study on Heavy Equipment with Its Latest Technologies and Recommendations for Its Usage for Different 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 consist of brief study of matches, similarity and dissimilarity of the equipment .

**Keywords**—Metro Rail, Construction, Heavy Equipment, Cluster Analysis

## I. INTRODUCTION

The equipment used on construction played a decisive role. Huge construction project is not even possible with the help of man power so it necessary to use equipment for the execution of huge construction project. It is a common fact that there is a wide variety of construction machines on every construction sites, which make the construction works easy, safe and quicker.

The use of new equipment and different innovative methods has made possible to changes in construction technologies in recent few decades.

Now a days there are lots of manufacturer are available for providing construction equipment and also with different models. Different models will have different fuel consumption, different maintenance requirements.

The selection of the proper type and size of construction equipment for a certain work also often affects the required amount of time and effort hence the job-site productivity of a project.

## II. OBJECTIVES OF THE STUDY

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.

## III. METHODOLOGY

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.

## IV. INTRODUCTION OF THE EQUIPMENTS

List of few equipment used while execution of metro project.

- Earth-moving equipment
- Hoisting equipment
- Hauling equipment
- Earth-compacting equipment
- Bar bending equipment
- Transportation equipment
- Aggregate production equipment
- Lifting equipment
- Equipment used in concrete construction
- Pile-driving 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.

## V. 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)

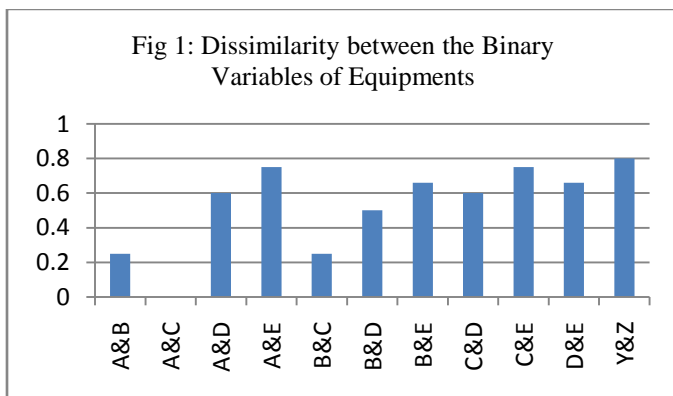
Type	Classification	Avg. Fuel Consumption	Power Output	Capacity	Maint. Required
A	1	1	1	0	1
B	1	1	0	0	1
C	1	1	1	0	1
D	1	0	0	1	1
E	1	0	0	0	0

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

Type	Classification	Cost for Maintenance	Power Output	Time Consumption	Maint. Required
Y	1	1	1	0	1
Z	1	1	0	0	1

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



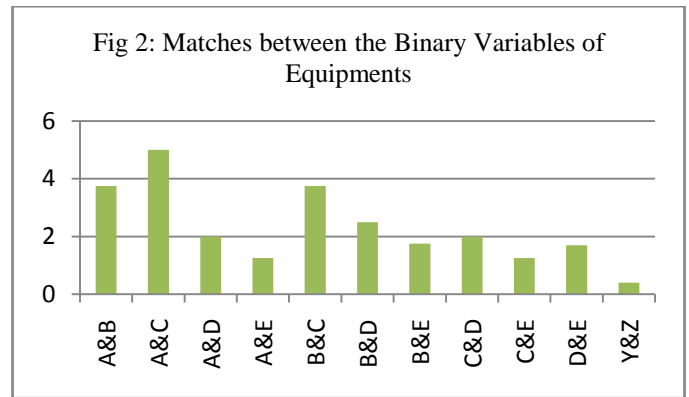
### 2) Categorical Variables

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



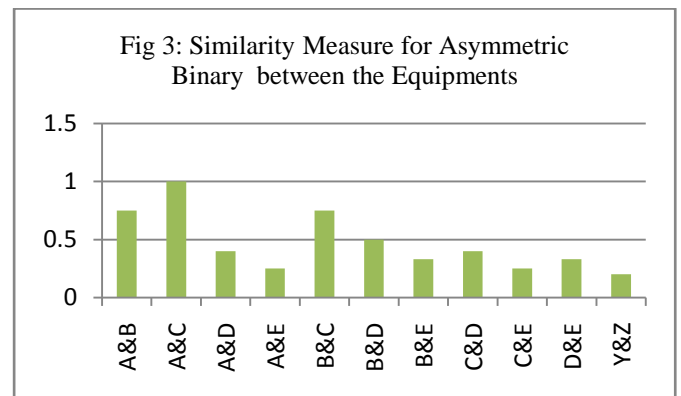
### 3) Jaccard Coefficient

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

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

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



### DISCUSSION

As it is obvious that different models of equipment will have different fuel requirements and maintenance requirements. The

above done analysis shows us the similarity, dissimilarity and Matches for the above mentioned equipment with the help of that one can compare the fuel and maintenance requirements and select suitable or similar equipment. Unfortunately there was many accidents occurred while construction of Metro Project in which most of them were related to equipment, For safety and precaution one should consider some factors likemore adequate operating clearance, more skilled operator for critical work, Prevent overloading as in Mobile crane lack of safety devices or limited switches.

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