Mahatma Gandhi National Rural Employment Act
TIME AND MOTION STUDIES
Capacity Building Workshop
21-06-2018

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Scheme of Presentation

- Introduction, MGNREGS, SoR
- Objectives of the Time and Motion Study
- Basic Methodology of Time and Motion Study
  - Concepts , definitions, estimations procedures
- Application of Time and Motion Methodology in MGNREGS
  - Major Challenges, operationalization of Time and Motion Methodology
  - Data Collection
- Statistical Solutions and Estimation of standard time and output
- Reporting

Preamble

- **For enhancement of Livelihood Security of rural households by providing at least 100 days of guaranteed wage employment in every financial year to every households whose adult members volunteer to do unskilled manual work.**

Focus of the program

- Wage employment
  - Livelihood security , Gender etc
- Assets Creation
  - Ecological Security , Connectivity , infrastructure
- Decentralized Governance
  - Strengthening grassroots democracy and planning
  - Labour budgeting and GPDP

Understanding the letter and spirit of the Act

- Right based framework
  - Right to demand work
  - Right to employment within 15 days
  - Right to wages with in 15 days
- Labour intensive work
  - 60:40 labour material ratio
  - No contractors and machinery

EMPLOYMENT GUARANTEE .SCHEMES AND UNEMPLOYMENT ALLOWANCE

- Section 4 This section provides that for the purposes of giving effect to the provisions of section 3 every state government shall by notification make a scheme , for providing not less than 100 days of employment to every households in the rural area coverd under the scheme.
- Section 5 specify conditions for providing guaranteed employment
- Section 6 Wage Rate Minimum Wage Act 1948 the central government may notify the wage rate for the purpose of this Act
- Different wages for different areas
- Until such time , a wage rate is fixed by central government in respect of any area in a state, the minimum wage fixed by State Gov for agricultural labors shall be considerd as the wage rate applicable for that area

Minimum features of the employment guarantee scheme

- Para 16 17 18 19
- 16 Payment shall only be made based on measurement taken at works site by authorized personnel within three days of closure of the muster roll
- 17 The State government shall link the wages without any gender bias with the quantity of work done and it shall be paid according to the rural schedule of rate fixed after time and motion studies for different types of work and different seasons and revised periodically
- 18 A separate schedule of rate shall be finalized for women, the elderly people with disabilities and people with debilitating ailments so to improve their participation through productive work.
- 19 a Schedule of rates of wages for various unskilled labors shall be fixed up so that an adult person worked for eight hours which include an hour of rest will earn a wage which is equal to the stipulated wage rate.
- 19 b Working hours of an adult shall be flexible but shall not spread over more than twelve hours of any day.

Objectives

Objectives of Time and Motion study

- To estimate standard time taken by MGNREGS workers to produce a specific quantity of output across different agro ecological zones and seasons,
  - Threshold output for minimum wage
- To build a rationale for revision of SoR of wages for MGNREGS works

Basic Methodology

Basic Methodology of Time and Motion Study

- Time study is the recording of time needed to do a certain amount of work in certain way, tied with specific method;
- Motion study is a systematic observation, analysis, and measurement of the separate steps in the performance of a specific job. The motion study is to find the greatest economy of effort with due regard for safety and human aspect
- Time Study and Motion study are different; but it is essential to use them together to determine a production standard , improving procedures, and increasing productivity

Basic Methodology of Time and Motion Study

- Time study permit us to understand complete cost of labor and also provide fixed base so the worker will know what is expected of him/her during a certain period of time.
- The time and motion study help us to establish the minimum expected rate of production on each job (to which it is applied for the base money rate (SoR) being paid for that job)
- The same amount of work can be accomplished in less time with more efficient application of human effort which will justify higher hourly wage rate

Linkage between T&M Study and Wages

- The base money rate may change from time to time due to changing economic conditions and social outlook but the time standard should remain the same as long as the method of doing the job is not changed
- Though the use of motion and time study, the unit base of measure for extra pay for extra production above the acceptable minimum is established

Important Concepts of T&M Study

- Work is defined as an activity in which a person exerts physical and mental effort to accomplish a given task or perform a duty. The task or duty has some useful objective.
- Work consists of tasks. A task is an amount of work that is assigned to a worker or for which a worker is responsible. The task can be repetitive (as in a repetitive operation in mass production) or nonrepetitive (performed periodically, infrequently, or only once).

Pyramidal Structure Work

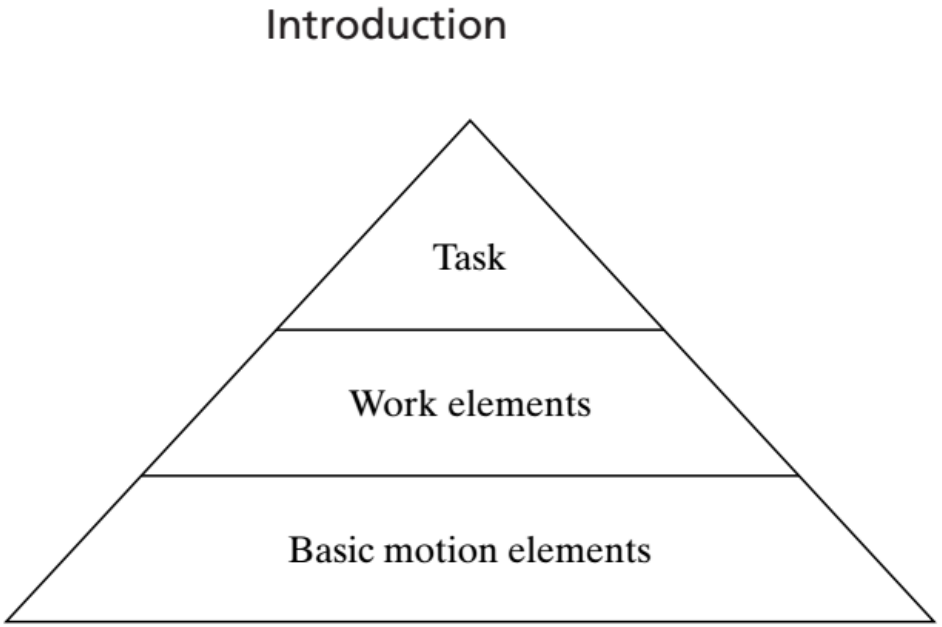


Figure 1 The pyramidal structure of a task. Each task consists of multiple work elements, which in turn consist of multiple basic motion elements.

Work Measurement Methods

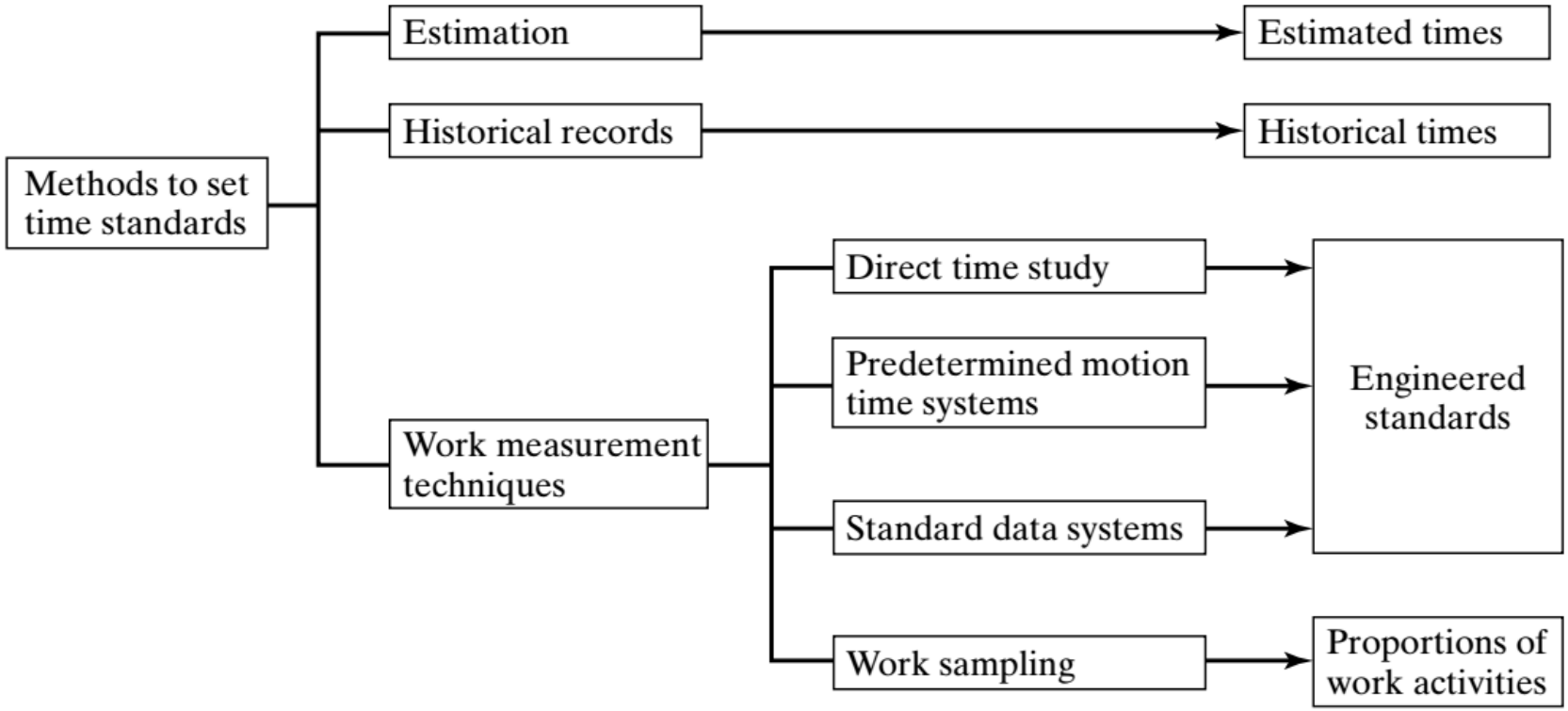


Figure 1 Classification of methods to determine time standards.

Relative accuracy of different methods

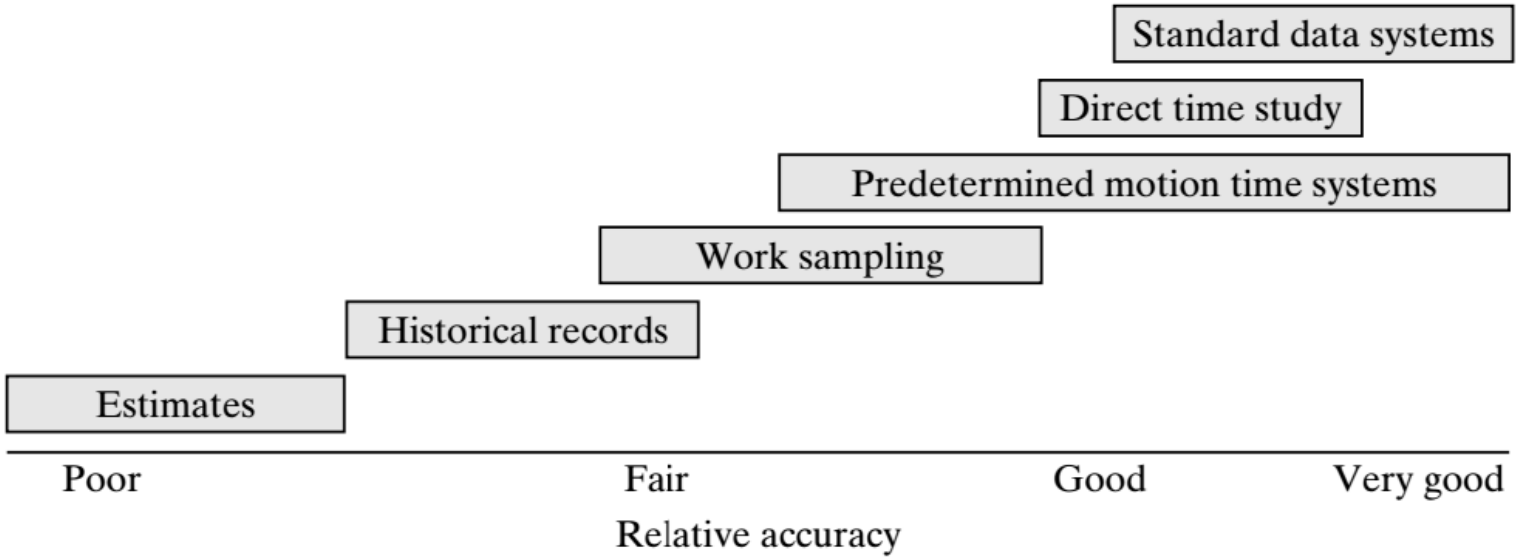


Figure 7 Methods of determining time standards ranked by relative accuracy.

Direct Time Study

Direct Time Study

- Direct time study (DTS) involves direct observation of a task using a stopwatch to record the time taken to accomplish the task.
- While observing the worker, the time study analyst evaluates the worker's performance (pace), and a record the pace attached to each work element time

Direct Time Study

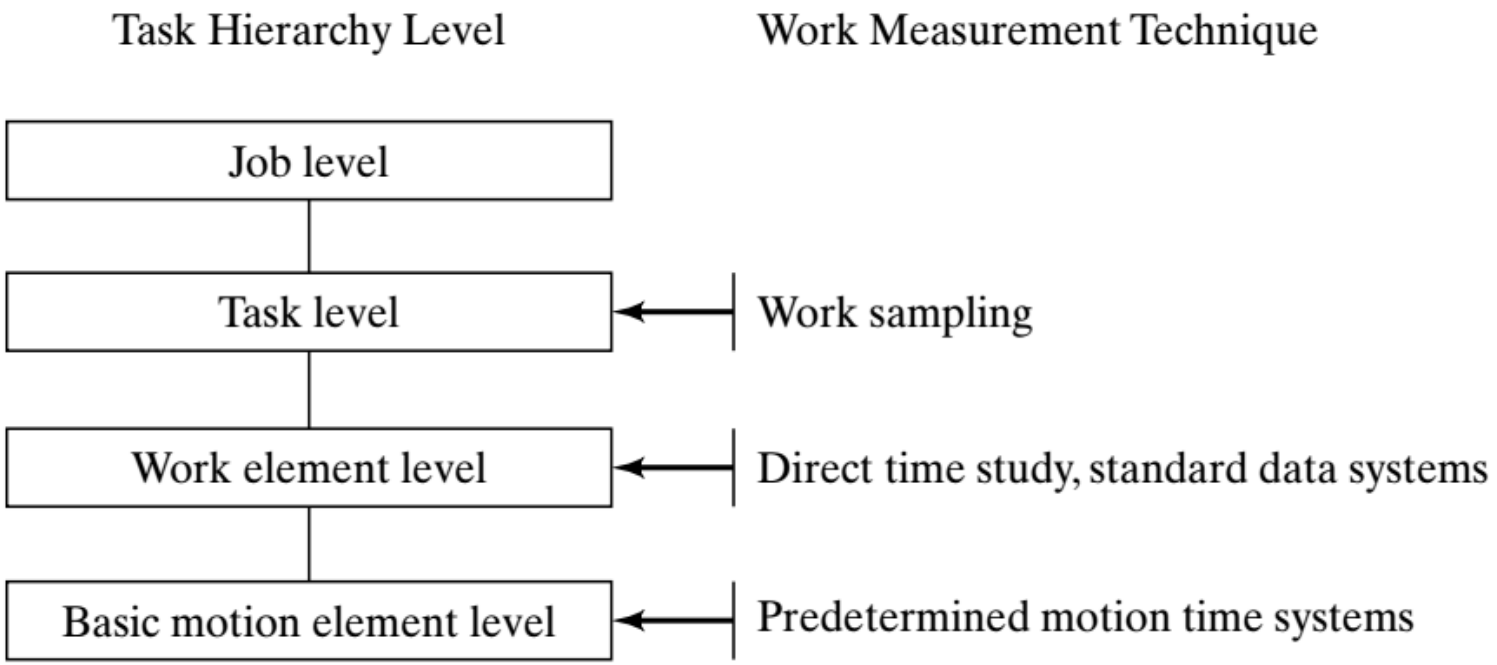


Figure 2 How the work measurement techniques correspond to different levels in the general task hierarchy.

Is determining the elements of a job necessary?

- It is depending up on the job under study
- Time value of a job
  - To secure the overall time to do the whole job and divide this time by number of pieces to get a unit measure
  - To determine the time for each motion and a total of whole the motion times for one unit produced to give a unit measure
- Between these two, researcher has the freedom to justify any number of possibilities,
- Other words job is broken down into parts and the parts are timed
- These parts are known as elements
- No fixed regulation how a job can be broken down into elements

Procedure for determining the standard time

- Step 1 Define and document the standard method.
- Step 2 Divide the task into work elements.
- Step 3 Time the work elements to obtain the observed time for the task.
- Step 4 Evaluate the worker's pace relative to standard performance, a procedure called performance rating. (This is used to determine the normal time. Steps 3 and 4 are accomplished simultaneously).

Procedure for determining the standard time

- Prepare a Process chart if necessary
  - the study of a series of steps involved in completing or series of events a person goes through in completing a job assignment
- Prepare a Flow chart if necessary
  - supporting route of travel that a person may take in completing a series of steps in a job assignment . The chart is usually used to supplement the process chart
- Prepare an operation chart if necessary
  - detailed analyst of just what an employee does in a specific step or task
- Prepare a micro motion chart if necessary.
  - An elaborate break down of an operation chart into very fine motions pattern showing what the employee does in a specific step or task

Procedure for determining the standard time

- Steps 1 and 2 are preliminary steps before actual timing begins, during which the analyst becomes familiar with the task and attempts to improve the work procedure before defining the standard method.
- In steps 3 and 4, each one performance rated independently.
- Finally, the values collected in steps 3 and 4 are averaged to determine the normalized time.
- An appropriate allowance factor for the kind of work involved is then added to compute the standard time for the task

Points for preparing an Operation Chart

- You have to identify operations that can be eliminated or combined with others
- You have to identify what operation is not absolutely necessary to accomplish the task so that a more effective use of effort can be suggested ?
- If you are observing the work element in an operation, make sure that each element should have a definite start and end point , in order to secure comparable time value for same element.

Recording the actual time values

- What method of stop watch reading time is going to be used?
- When have an adequate number of stop watch reading been secured?
- The accuracy depends on the person who handle stop watch
- *Continues Stops Watch Reading and Recording*
- The stop watch start at the beginning of the first element of the job description and runs continuously until the study is completed – the time for each element is secure by subtracting successive reading
- *Continues Stops Watch Reading and Recording*
- The stop watch start at the beginning of each element
- We recommend a complete time study of the whole job from the first piece to the last piece during 8 hours in MGNREGS Works.

Work measurement

- The objective of these work measurement techniques is to determine a standard time for the job (task)
- time study refers to all of the ways in which time is investigated and analyzed in work situations, whether the work is accomplished by human workers
- Most workers are paid on the basis of time. The common work shift is 8 hours per day.
- How much work did the worker accomplish in those 8 hours? Has the worker done a fair day's work? Time standards provide a way to answer these questions.
- The most meaningful and useful measure of work is the amount of time it takes to accomplish it.
- Time is objective. It is quantifiable. People understand time.
- The standard time for a given task is the amount of time that should be allowed for an average worker to process one job using the standard method and working at a normal pace.
- The standard time includes some additional time, called the allowance, to provide for the worker's personal needs, fatigue, and unavoidable delays during the shift

A complete time study of the whole job from the first piece to the last piece during 8 hours of MGNREGS work

- Generate observed time data and record it using a questionnaire for 8 hours
- Use of continues Stop watch will help use to time taken or wasted during the work in each job element
- Active, Passive, break, idle time can be differentiated using a stop watch and questionnaire
- Observed time is the active time spent for completing the work after subtracting break time
- You will generate observed time data for different category of workers in different jobs (template) across agro-climatic regions and seasons

How to Rate performance ?

- It is done through observation based on a benchmark?
- Equity of rating, all rate must practice fairness, all raters in one work (plant) must use the same basic reference in other cases, rating must be concrete and based on some observable basis.
- Observation is highly subjective and can be biased, What solution?
- One way of assessing performance is to assess the human effort by calculating the physical activity level of the workers under study.
- How do we calculate the PAL?

How to Rate performance ?

- Develop an index of effort based on the physical activity intensity of undertaking different activities – digging, earthwork, carrying weights etc. and link SORs to the index of effort.
- Suggested index of effort: Physical Activity Level (PAL)
- PAL = Total Energy Expenditure/Basal Metabolic Rate.
- Basal metabolic rate (BMR) = Energy required by a human being at rest – function of age, gender, height and weight – number of estimating equations available.
- Total Energy Expenditure = BMR + Activity Energy Expenditure.
- PAL is a ratio of total Energy expenditure to BMR with minimum value of 1
- Use recent advances in wearable technologies – to accurately assess activity energy expenditure.

What are the challenges you may face while generating observed time data for a complete study of whole job?

- Whatever the work, observation will show that people differ in manner and speed at which they accomplish the task. (capture variability in motion)
- How to watch different people doing different work at different speed and how to compare them to some person who is working at a certain speed already determined for a certain existing area (rating or leveling)

Determining and Applying Allowances

- Regardless of occupation, certain interruptions will occur during a regular working day
- Different degree of interruptions (short, moderate and long)
- Delay due to work situation should not be permitted to act as a penalty upon operator .
- Stoppages which are long enough to be recorded on a time card do not present a measurement problem because the time card is a measurement devise in this case
- We need to define policy which type and duration of delay are to be covered in the delay allowances in time study and which are to be covered in time card –operational issue

Determining and Applying Allowances

- Proper allowances for delay are essential if fairness to all is to be achieved (allowances for food toilet etc.,)
- The amount of delay that can be expected in various types of work have a definite relationship to the production time , basically the acceptable total work day is composed of net production time and acceptable delay time.
- Delay to be allowed as a percentage of the base time or net production time after various delays percentage are known.
- Production standard time allowed in this case for one piece

Observed, Normal, and Standard Time

- The observed time is multiplied by the performance rating to obtain the normal time for the element or the task

$$T_n = T_{obs}(PR)$$

- To determine the standard time for the task, an allowance is added to the normal time to provide for personal time, fatigue, and delays. The calculation of the standard time is summarized in the following equation

$$T_{std} = T_n(1 + A_{pfd})$$

Applying Time and Motion Methodology in MGNREGS Works

Important Concerns Under MGNREGS

- It is public work Programme targeting Unskilled labors
- 7 hours of work and 1 hour break , flexible for 12 hours
- Group Work of heterogeneous group of people (elderly, women, physically challenged, debilitating health)
- Average group size is 15 to 20
- They are engaged in officially approved works, mostly earth works, desilting, road, plantation, nursery, masonry.

Important Concerns Under MGNREGS

- It is done private land and common property
- Using only few implements, no machinery
- Work provided irrespective ecological and seasonal character
- Output measured at group level
- Individual effort of participants is difficult to monitor- potential for participants to put in sub-optimal level of effort.

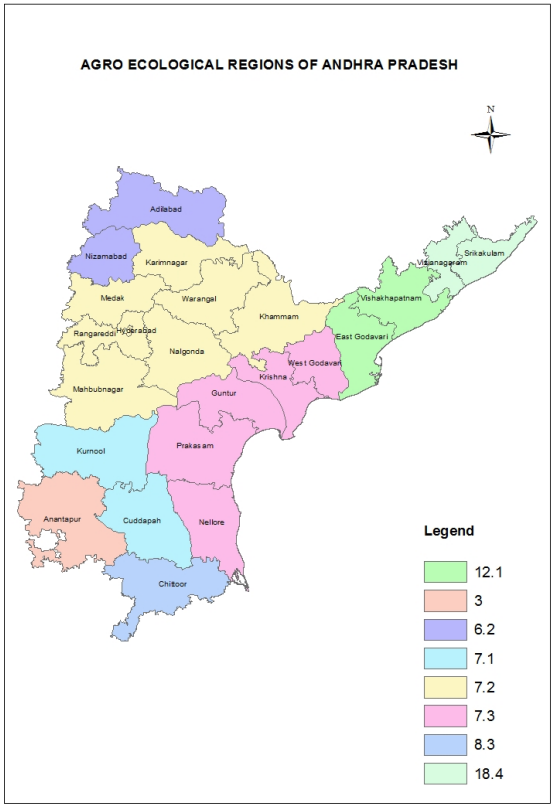
Taking Sample

Take into consideration level 2 of the agro ecological regional classification

Repeat the experiment for different Seasons

Worksite can be selected randomly

As a thump rule, 20 sample for one job, it should not be less than 10



Steps to be considered while Applying Time and Motion Methodology in MGNREGS

- Find out how a job (task) is being done in an approved MGNREGS work
- Thoroughly question the reasons for each step as it is being done now on the job
- Remove the step on the job which cannot be fully justified
- Identify elements and Prepare Process charts, flow charts, operational charts
- Content of each element should be homogenous as possible
- The same element of work will appear in different job – especially in similar work

Identify a Job (task) under MGNREGS Approved Work

- Identify as per MoRD T&M Template, (in different location and seasonal context)
  - The final template prepared by MoRD covers
  - Earth work 18 items
  - Desilting 2 items
  - Road Works 14 items
  - Social Forestry Plantation 22 items
  - Nursery raising 19 items
  - Masonry concrete 37 items
  - Total 122 items

Main Activity	Elements
Land preparation/Levelling	Taking Crowbar/Sickle in to hand
	Walking to work place
	Bush Clearance
	Walking to Instruments place
	Keeps Crowbar/Sickle
	Break for water/cigarette/others (10-15 Min)
	Taking Spade and Iron Basket in to hands
	Walking to Bush cleared place
	Collecting of bush cleared
	Carrying and dumping of removed bush
	Walking to Instruments place
	Keeps Spade and Iron Basket
	Break for Lunch (30-45 Min)
	Taking crowbar/Iron Basket in to hands
	Walking to work place
	Removal of pebbles, boulders, Soil
	Lifting of pebbles and boulders according to size
	Carrying and Dumping of the same
	Walking to Instruments place
	Keeps Crowbar and Iron Basket

Process Chart (Hypothetical)

Distance	Symbol	Explanation
		Rest on the earth
20 ft	---------	Walking to Material place
		Taking Marking material in to hands(i.e Rope,cowbar,spade,etc)
20 ft	---------	Walking to Marking area
		Marking of area to be dug
		Break for Water/Tea/Cigarette etc.
		Digging the earth
		Removal of soil in to Iron basket with spade
50 ft		Carrying basket
		Dumping of Soil
50 ft	---------	Walking to Marking area
20 ft		Keeping material at material palce
20ft	---------	Walking to resting area
		Rest on the earth

SUMMARY
No of Operations 4
No of movements : 3
Distance for movements:160ft
No of Material items:4

Operational Chart (Hypothetical)

Distance/time	Symbol	Explanation
		Rest on the earth
15 min		Waiting for order to move to work place from resting area
20 ft	---------	Walking to Material place
10 min		Time taken to catch material
		Taking Marking material in to hands(i.e Rope,cowbar,spade,etc)
20 ft	---------	Walking to Marking area
5 min		Chitchat for being ready for taking marking area to be dug
		Marking of area to be dug
		Break for Water/Tea/Cigarette etc.
		Digging the earth
		Removal of soil in to Iron basket with spade
50 ft		Carrying basket
		Dumping of Soil
50 ft	---------	Walking to Marking area
10 min		idle time
20 ft		Keeping material at material place
20ft	---------	Walking to resting area
		Rest on the earth

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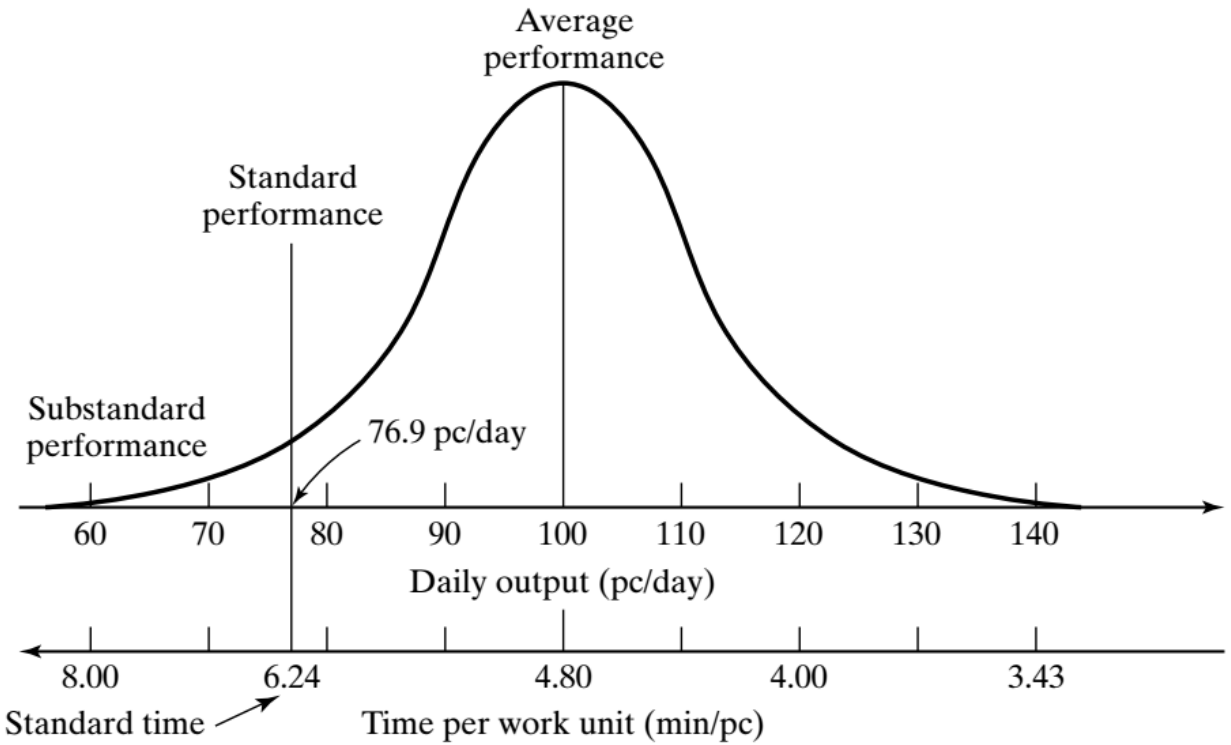

Figure 5 Distribution of performance and task time for large numbers of workers, indicating how standard time is typically defined as a time that can be readily achieved by most workers.

Sampling, Study Process and Data collection: Suggestions

Steps recommended

- Activity: Earth bunding taken up in plain area in summer season (context specific)
- Identify all worksites where the stated activity is being taken up in a district (during summer season)
- Develop a sampling frame of such worksites preferably in each district separately
- Draw one worksite randomly from each sampling frame relating to a particular district (by using Random Number Table)
- The minimum sample size should not fall short of 20 across the state (in case the stated work is taken in districts less than 20 in a state, draw more than one sample from (some) districts
- Observe the composition of the group at the worksite and put all the workers into five homogeneous groups viz., able bodied, elderly males, elderly females, disabled and sick workers

Steps Recommended

- Note the work starting day and work ending day- the ending day could be in parts
- A day is reckoned as the one with eight hours' duration and with one hour rest/lunch break
- It may be noted that for this experiment, the workers should not be asked to do a given quantum of work and only the activity / work to be done will be specified to the workers
- In view of this, the total quantum of output is expected to vary from worksite to worksite depending upon the composition of the group of workers
- Record the time taken (observed time) after completion of the work
- The size of the total group need not be uniform across worksites., but broadly it is expected to vary between 10 and 20. And, in some cases, there are separate groups for disabled and in some other cases, there may not be any sick persons present in the group.

- In case a work takes about four days and the group composition changes from day to day, the average number of such group people may be considered. For example, out of four days of work, two disabled participated for just two days, we will take the disabled as two only (ie., total possible disabled persondays which is eight (4 days x 2 persons) divided by actual disabled persondays which is 4 (2 days x 2 persons)
- Once the matrix is ready where we have the composition (in terms of five groups referred to above) of workers across all 20 sites, compute the time taken for producing per unit output. This can be obtained by dividing the estimated standard time taken which is in terms of days by the actual output turned out and the resultant value is called Standard Time taken for producing unit output or (TTPUO).

- TTPUO varies across the 20 worksites depending upon the composition of the group and the group having relatively higher able-bodied members is expected to show output in lesser amount of time than others. In other words, there is a negative correlation between the number of able- bodied members in a group and the corresponding TTPUO. And, similar hypotheses can be postulated in respect of other groups too. For example, sick people do contribute to the total output but it may not be that significant in comparison to others.
- This being so, there exists some variability in TTPUO values across worksites.
- To assess the contribution of each group to the total variation in TTPUO, a linear regression is fitted where TTPUO is taken as dependent variable and the number of members in each group (able-bodied, elderly males, elderly females, disabled and sick persons) of a worksite are taken as independent variables

Statistical Solutions and Estimation of standard time and output : Fictitious example

Fictitious example

- Given below is a fictitious example where we have details of about 20 worksites on TTPUO and the corresponding values on five groups.
- The value of R^2 of 0.914 implies that the five independent variables considered in the model are able to explain 91.4 per variation in the dependent variable and the value of F-ratio is 14.287 which is significant at 1 per cent level. This shows that the model is the best fit.
- The regression coefficients for two independent variables namely able-bodied and elderly males turn out to be significant at 1 per cent level, as t-ratios reveal.
- The interpretation of regression coefficient in respect of able-bodied group is that if the size of the group increases by one member, the TTPUO will come down by 0.005 day.

Fictitious example

- Regression Equation:
- **TTPUO= 0.254 -0.005 X1 - 0.004 X2 - 0.002 X3 + 0.002 X4 + 0.001 X5**
- On plugging the values in column 3 of the above table, the total value will work out to **0.19455** which can be interpreted as the time taken in days for producing one unit of output by an average group the composition of which is as given in col. 3 of the table.

Fictitious example

Group	Total members across 20 worksites	Strength per worksite
(1)	(2)	(3)
Able - bodied members (X1)	86	4.30
Elderly males (X2)	75	3.75
Elderly females (X3)	64	3.20
Disabled (X4)	31	1.55
persons (X5)	7	0.35

Fictitious example

Group_No	Able_bodied	Elderly_Male	Elderly_Female	Disabled_Person	Sick_People	Time_Taken	group__output	TTPUO
1	4	5	3	2	0	3	13.953	0.215
2	6	3	2	4	0	4.5	21.028	0.214
3	7	5	4	1	3	5	25.641	0.195
4	5	4	2	1	1	3.5	16.129	0.217
5	3	4	7	2	0	7	31.963	0.219
6	5	4	4	4	0	4	18.779	0.213
7	5	3	2	5	0	4	18.1	0.221
8	2	7	4	1	0	6	27.397	0.219
9	6	4	3	1	0	5	24.752	0.202
10	5	5	2	0	0	4.8	23.515	0.202
11	1	6	5	2	0	4.5	20.93	0.215
12	2	4	4	0	0	4.5	20.455	0.22
13	4	0	4	2	0	5	21.645	0.231
14	5	4	2	1	0	5.5	25.229	0.218
15	4	2	3	2	1	4.5	20.455	0.22
16	6	4	2	0	0	6	30	0.2
17	3	2	3	1	1	7	30.435	0.23
18	4	3	3	0	0	6	27.523	0.218
19	4	4	3	1	1	6	27.273	0.22
20	5	2	2	1	0	5	23.041	0.217

An MGNREGA Worksite West Bengal

Thanks

- *Examples used in this presentation is fictitious, do not copy or use for any research purpose.*
- *Literature and idea drawn from various published papers.*
- **Presentation Prepared by: Jyothis Sathyapalan and S V Rangacharyulu, CWE NIRDPR. Hyderabad**