Chapter 8
WORK SAMPLING

Work Sampling

- Work sampling is a technique in which a large number of instantaneous observations are made over a period of time of a group of machines, processes or workers.
- Each observation records what is happening at that instant and the percentage of observations recorded for a particular activity or delay is a measure of the percentage of time during which that activity or delay occurs.
- Work sampling is also known as: Activity sampling, ratio-delay study; observation ratio study; snap-reading method; and random observation method;
- Activity sampling provides a solution.
- It is a statistical technique originally developed under the title of "snap reading technique" by L. H. C. Tippett in 1934.
- Activity sampling, as its name implies, is a sampling technique.

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- It Involves making a series of tours of the shop at irregular intervals, noting the machines working, the machines stopped and the cause of each stoppage.
- If a sufficiently large number of readings are taken at random intervals the percentage of readings recording a machine working will tend to equal the percentage time it is doing so.
- The percentage of readings recording an operative as doing a certain operation or group of operations is an estimate of the percentage of time actually spent on these operations.
- If the readings are distributed at random over a long enough time this relationship holds good whether the stoppages are short or long, many or few, regular or irregular.
- The type of information provided by an activity sampling study is
- The proportion of the working day during which workers or machines are producing.
- The proportion of the working day used up by delays.
- The reason for each delay must be recorded.
- The relative activity of different workers and machines.

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- In all sampling there is bound to be some error between the data obtained from the sample and the facts.
- The larger the sample the nearer the data will be to presenting a true picture of the facts.
- The error which is inherent in the observed percentages, or conversely, the number of observations required to obtain a required degree of accuracy, are calculable from a simple formula.
- If the machine is running he makes a mark or a tick and passes on to the next; if it is stopped he must find out the reason, ii this is not obvious.
- He then marks against that machine a code letter to denote the cause of the stoppage.
- Two things are specially important. The first is that, although the observer may follow the same path every time, each tour should be made at a different time of the day.
- The second is that each observation should be made at the same point relative to each machine, He should not note what is happening at machines ahead of him as this tends to falsify the study.
- Operatives must be persuaded to carry on as if the observer were not there. If they are resting they should continue to do so.

Forms used in work sampling

Date: Observer: Study No.:

Machine or operative	Tour No. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
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Code:

Machine running	√	Warp break	T	Operative working	W
Change-over	X	Empty battery	B	Operative resting	RA
Cleaning	C	Weft break	W	Operative absent	PA
Maintenance	M	Smash	Sm		

Simple record sheet

Date: Observer: Study No.:

Number of observations:		Total	Percentage
Machine running	卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 ||	62	82.7
Machine stopped	卌 卌 |||	13	17.3

WORK SAMPLING PROCEDURE

1. Identify the specific activities or workers that are the main purpose for the study:

- The selected worker should be representative of the group and should be familiar with standardized work methods.
- The workers and supervisors should be notified of the purpose of the study.

2. Plan the sampling procedure

A. Determine the number of observations to be made:

i. Determine the confidence level.

ii. Set the accuracy limits.

iii. Apply the following formula.

Sample Size (Number of Observation)

$$N = \frac{Z^2\, p(1-p)}{E^2}$$

where,

- *N*= Number of observations to be made
- *Z* = Number of standard deviations associated with a given confidence level
- *p* = Estimated proportion of time that the activity being measured occurs
- *E* =Absolute error that is desired
- E = (s * p)
- S = accuracy of the sample results

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B. Determining the time to make observations:

- Random observations
  Use of a random number table. For example, a work sampling study is to be conducted over a 1- week period of five 8- hour workdays, the total number of minutes would be (60 x 8 x 5) = 2400 minutes.
- A four-digit column of random number could be used to select numbers between 0000 and 2400.
- In case of few observations, some form of alarm watch or other system is used.
- The number of observations to be taken is usually divided equally over the study period.
- For example, if 500 observations are to be made over a 10 day period, observations are usually scheduled at 50 per day.

D. Take the observations

- At two or three intervals during the study period, recompute the required sample size by using the data collected so far.
- Adjust the number of observations if appropriate.

Illustration

- A preliminary study is first made, totaling 100 observations the observer has made ten tours of the shop at different times of the day, and has noted on each tour which machines are working and which are stopped. It was found that the total of 100 observations was made up of 70 observations of machines working and 30 of machines stopped. If we are prepared to accept an accuracy of ± 5 per cent. in the result we finally obtain for the proportion of machines stopped (i.e. S = 0.05). calculate the number of observations required before we can feel 95 per cent sure that the sample results represent the true situation.

Solution

- The percentage of the phenomenon we are interested in machines stopped thus appears to be 30 per cent., or, expressed as a decimal, 0.30. The value of "p" for the formula is therefore 0.30.
- S = accuracy of the sample results = 0.05
- p = percentage of idling = 0.3
- q = percentage of activity (1 – p) = 0.7
- Z = coefficient of the confidence level = (2, fro 95% of confidence level)
- E = absolute error (s x p) = 0.05 * 0.3 = 0.015
- N = number of observation = ?

$$\mathbf{N} = \frac{Z^2\, p(1-p)}{E^2}$$

Conti…

$$\mathbf{N} = \frac{\boldsymbol{Z^2\,p(1-p)}}{\boldsymbol{E^2}}$$

$$\mathbf{N} = \frac{\mathbf{2^2 * 0.3 * 0.7}}{\mathbf{0.015^2}}$$

$$\mathbf{N} = \frac{\mathbf{4 * 0.21}}{\mathbf{0.000225}} = 3733.33$$

- Entering p = 0.30 and S = 0.05 yields a value for N of 3,733 observations, which we may round off to 4,000.
- As there are ten machines this indicates a total of 400 tours, which could be accomplished by a single study man making 40 tours a day, at intervals of approximately 12 minutes, for ten working days.

Conti…

- Suppose that at the end of the first day approximately 400 observations will have been completed. Let us suppose that 100 of these were of machines that were stopped.
- What should be the percentage of machine idle and how many observation are required to give the required degree of accuracy (S = ± 0.05) with 95% confidence level.

$$P = \frac{\text{number of observation where the machines are idle}}{\text{Total number of observation}} = 100/400 = 0.25$$

$$\mathbf{N} = \frac{\mathbf{2^2 * 0.25 * 0.75}}{\mathbf{(0.05 * 0.25)^{\,2}}} = \frac{\mathbf{0.75}}{\mathbf{0.00015625}} = 4800$$

At the end of 12 days, when 4,800 observations had been taken, it was found that 1,344 of these were on machines which were stopped, so that the final value of p was

$$\frac{\mathbf{1344}}{\mathbf{4800}} = 0.28 = 28\%$$

- Introducing this figure into the formula, and also the final value for N (4,800), permits solving for S, the accuracy of the observation.
- When this is done, S comes out at 0.046, or 4.6 per cent.
- This is less than the ± 5 per cent. originally sought, so enough observations have been taken.
- It may thus be said that there is a 95% chance that the actual proportion of machines stopped will average 28% ± 4.6%.
- We may therefore be 95% confident that the machines are stopped between 32.6 and 23.4% of their time.

ADVANTAGES

- It is a less expensive procedure.
- Observers with minimal specialized training can conduct the sampling.
- It is an effective means of collecting facts that would not normally be collected by other means.
- Several operators or machines may be observed simultaneously by a single observer.
- No mechanical device needed.
- It results in less anxiety and agitation among workers.
- There is minimal interference with the worker's normal routine.
- It measures the utilization of people and equipment directly.
- A work sampling study may be interrupted at any time without affecting the results.

DISADVANTAGES

- It is not economical for studying a single operator or machine, or for studying operators or machines located over wide areas.
- It cannot provide a much detailed information .
- The operator may change his or her work pattern upon sight of the observer.
- It is of little value in helping to improve work methods.
- A lot of groundwork is required.
- A work sampling study made of a group obviously presents average results, and there is no information as to the magnitude of the individual differences.

SUITABILITY

- Group activities,
- Non-Repetitive activities with long cycle times (example: maintenance operator, support personnel, etc.),
- Activities that are not rigidly constrained from the time standpoint,
- Heterogeneous activities.