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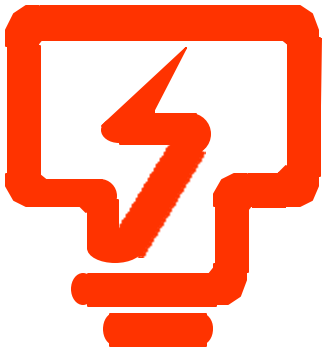

TENAGA NASIONAL

CMBA 611: Management of Operations

Microsoft PowerPoint® Presentations

to Accompany

Operations Management, 2/e

by James B. Dilworth

Ohio University Corporate MBA Program

Supplement F
Work Measurement and Time Standards

Work measurement

What is it?

It's the application of techniques to determine the *time* needed for a *qualified* worker to *properly* perform a task

The time that a job is expected to take is called its "time standard"

Aliases include "work standard," "production standard" and "standard"

Work measurement

Uses of time standards

Capacity planning

To know how much capacity will be required for a given (forecasted) level of output

Scheduling

To be able to accurately predict product delivery dates and schedule workers' assignments

Loading

To see that sufficient (but not excessive) work has been planned to use processes and human resources efficiently and equitably

Work measurement

Uses of time standards cont.

Cost estimation

To be able to accurately predict the wage component of the cost of producing goods and services

Evaluation

To be able to compare (proposed) alternative methods and/or process steps in order to determine their merit and to determine if employees have attained some basic skill level

Work measurement

Where work measurement can be applied

The three criteria for measurable jobs

1. The work must be quantifiable (e.g., in terms of the number of units a worker performs)
2. The work should be performed in a reasonably consistent manner
3. There should be a sufficient volume of work to justify its study

Work measurement

Methods used in setting standards

Time study

A (stopwatch) time study is performed by timing a worker as the job is performed

The times for the necessary elements of the job are measured and then added and the resulting sum is adjusted for any abnormal work pace

Finally, additional time for personal time and rest breaks are added

Work measurement

Methods used in setting standards

Time study cont.

The worker being timed should be notified and a considerable number of job cycles should be measured

The first phase of the observations is to identify the *work elements* that comprise the job

Work measurement

Methods used in setting standards

Work elements are important because

1. Understanding a job's elements fosters a deeper understanding of the job itself

   In addition, bottlenecks (i.e., the most time consuming elements), which are likely candidates for improvement, can be more readily identified at the element level

Work measurement

Methods used in setting standards

Work elements are important cont.

2. Elements can be operator dependent so the analyst can make more accurate "performance rating" adjustments for the job at the element level (and thus arrive at a better estimate of the job's time for an average worker)

Work measurement

Methods used in setting standards

Work elements are important cont.

3. Machine-paced elements can (and should) be separated from those under the operator's control
4. Some elements may not be part of every job cycle so accounting for their impact on the job's total time may require that their elemental identity be preserved

Work measurement

Methods used in setting standards

Work elements are important cont.

5. The times for elements common to several jobs can be compared to help keep standards uniform
6. Similar to 5 (above), common element times can be cataloged into "standard data" which may be used to estimate element times for some future job (thus avoiding the need for another time study)

Work measurement

Methods used in setting standards

Determining the number of cycles to time

The more cycles timed, the more reliable (accurate) the results

After about 10-15 cycles have been timed and "outliers" have been discarded,

(what's an "outlier?")

A preliminary calculation can be made to estimate the total number of cycles that should be timed to ensure a specified level of accuracy

Work measurement

Methods used in setting standards

Determining the number of cycles to time

This “sample size” calculation assumes that a normal (Gaussian) probability distribution applies and ...

It employs the “confidence (probability) interval” approach from the field of probability and statistics

Work measurement

Methods used in setting standards

Determining the number of cycles to time

A 95% confidence interval means that intervals developed by this procedure will contain the actual (population) mean (μ) in about 95% of the cases

Work measurement

Methods used in setting standards

Determining the number of cycles to time

So the probability is 0.95 that the sample mean $\bar{x}$ estimates the actual mean μ to within a user- specified accuracy " $\pm$ A" where "A" is expressed as a decimal (per unit) fraction of the actual mean μ

Work measurement

Methods used in setting standards

Determining the number of cycles to time

$$n = \left[\frac{Z \times S}{A \times \bar{X}} \right]^2$$

Where: 1. n = The total number of observations required to attain accuracy "A"

2. A = The (user) specified accuracy (in pu) requirement for the estimate ($\bar{X}$) of the population mean (μ)

Work measurement

Methods used in setting standards

Determining the number of cycles to time

$$n = \left[\frac{Z \times S}{A \times \overline{X}} \right]^2$$

And: 3. $\overline{X}$ and S are the (sample) mean and standard deviation of data already collected

Work measurement

Methods used in setting standards

Determining the number of cycles to time

$$n = \left[\frac{Z \times S}{A \times \overline{X}} \right]^2$$

And: 4. Z is the standard normal deviate such that the probability (area) in the "tail" of the distribution spanning the abscissa range $Z \leq \text{abscissa} < \infty$ is $(1 - P)/2$ where P is the confidence probability

Work measurement

Example (text p. 221)

Determining the number of cycles to time

Suppose a job element has been timed six times with the following results:

Observation No.	Observed Element Time X_i	X_i^2
1	0.07	0.0049
2	0.08	0.0064
3	0.11	0.0121
4	0.09	0.0081
5	0.05	0.0025
6	0.07	0.0049
	$\Sigma X_i = 0.47$	$\Sigma X_i^2 = 0.0389$

Work measurement

Example (text p. 221)

Determining the number of cycles to time

Suppose a job element has been timed six times with the

How many more observations are needed to estimate the mean time to within 10% accuracy with 95% confidence?

Observation No. | Observed Element Time X_i | X_i^2
1 | 0.07 | 0.0049
2 | 0.08 |
3 | 0.11 | 0.0121
4 | 0.09 |
5 | 0.05 | 0.0025
6 | 0.07 | 0.0049
$\Sigma X_i = 0.47$ | $\Sigma X_i^2 = 0.0389$

Ohio University Corporate MBA Program 22

Work measurement

Example (text p. 221) cont.

Determining the number of cycles to time

$$\bar{X} = \frac{\Sigma X_i}{N} = \frac{0.47}{6} = 0.07833$$

$$S = \sqrt{\frac{\Sigma X_i^2 - (\Sigma X_i)^2/N}{N - 1}} = \frac{0.039 - 0.47^2/6}{5} = 0.0205$$

$$n = \left[\frac{Z \times S}{A \times \bar{X}}\right]^2 = \left[\frac{1.96 \times 0.02050}{0.10 \times 0.07833}\right]^2 \approx 26 \text{ (i.e., 20 more)}$$

Work measurement

How much will the average (mean) of the 26 samples be above or below the actual mean m ?

Work measurement

Example (text p. 221): Using a *graph* to determining the number of cycles to time

Step 1: Calculate the coefficient of variation

$CV = \sigma/\mu \approx S / \bar{X} \approx 0.0205 / 0.07833$

≈ 0.2617 (about 26%)

Step 2: The number of samples is the ordinate of the 95% curve of text Figure F.2 (p.221) at abscissa 26%, which is about 90 samples

Why isn't it 26 samples?

Work measurement

Methods used in setting standards

Adjustment for worker's pace

The objective of a time study is to arrive at a standard that is suitable for a normal employee

However, the worker under observation may not work at a normal pace so …

A *performance rating* adjustment can be made to compensate for the difference (see the time-study sheet of text Figure F.1, p.220)

The *performance rating* is a judgment call

Work measurement

Methods used in setting standards

Normal time and actual time

The *performance rating* is used to relate the actual time (AT) taken by a particular worker to the normal time (NT) expected from a qualified worker working at a normal pace

NT = AT x Performance rating ÷ Normal efficiency

Where the normal efficiency is (usually) 100%

See text p. 222 for a numerical example

Work measurement

Methods used in setting standards

Standard time and allowances

Delay allowances are made for worker fatigue and other personal matters by adding a per-unit allowance term to the normal time to yield the *standard time* (ST) as follows:

ST = NT x (1+ allowances)

See text Figure F.2 (p.223) for some guidelines germane to personal and fatigue allowances

Work measurement

Methods used in setting standards

Accounting for unavoidable delays

One component of delay allowance is associated with unavoidable delays such as waiting for part(s) and/or tools

One way of measuring unavoidable delays is the *work sampling* method (ratio delay study)

Work measurement

Methods used in setting standards

The work sampling method

Rather than measuring time *duration* as in a time study, in work sampling many (nearly instantaneous) spot-check observations are made

Then the percentage of the total number of observations where an unavoidable delay is observed is taken to be the percentage of the job's normal time as well (see text p. 223 and Table F.3 for a numerical example of how this method is applied)

Work measurement

Methods used in setting standards

The work sampling method cont.

The total number of observations required is given by text equation [F.4] (which resembles text equation [F.1])

$$n = \left[\frac{Z}{A}\right]^2 x \left[\frac{1 - p}{p}\right]$$

Where: "p" is the (initial) estimate of the proportion of interest (e.g., obtained from ≈ 50 observations), "A" is the desired (per-unit) accuracy of the estimate of the (population) proportion and "Z" is the standard normal deviate for the desired confidence probability

Work measurement

Methods used in setting standards

The work sampling method example

Suppose 100 random observations (with the clock-time of each observation selected randomly) of a nurse at work results in 16 observations of unavoidable paperwork

How many observations are needed to be 95% confident that the true proportion of paperwork is estimated to within 10%?

Work measurement

Methods used in setting standards

The work sampling method example cont.

$n = (1.96 / 0.10)^2 \times (1 - 0.16) / 0.16$

$= 2016.84 \approx 2017$ observations (total)

If each observation takes 30 seconds to note & record, then the total time spent in observation *alone* is about 17 hours!

How can this be overcome?

Measure several nurses in parallel

Work measurement

Methods used in setting standards

Standard data

Some jobs may have (similar) elements in common

In such cases, element times might be plotted and then interpolated like the wooden-shelf sanding example on text p. 224

Work measurement

Methods used in setting standards

Standard data cont.

Note that the plotted points in Figure F.3 have been used as the basis for forming a straight line

How might this be done?

Simple linear regression (see Chapter 4)

How might such an approach fail?

Work measurement

Methods used in setting standards

Predetermined motion times and MTM

Predetermined motion times differ from *standard data* in that they decompose a job into much finer detail than the job elements that are used in the *standard data* approach

One of the better known predetermined motion-time techniques is *methods-time measurement (MTM)* where the analyst breaks down a manual task into elements whose times are published in standard tables such as text Figure F.4 (p. 225)

Work measurement

Methods used in setting standards

Historical records

In this approach, a department's (or a person's) output over a period of time is divided by the number of worker-hours expended

Because this approach is very coarse and its data is culled from historical records, it's simple but tends to be inaccurate since past conditions may not reflect present conditions

However, it can be used as the starting point (initial estimate) for some of the methods found elsewhere in this supplement

Work measurement

Methods used in setting standards

Employee self-timing

In this approach, employees are asked to keep records of their activities through time by way of a simple (sometimes codified) form

It's simple, requires little training and can be useful in analyzing service jobs and knowledge (mental) work where it may be impossible to observe the beginning and end of tasks

However, it doesn't take into account the impact of the (worker's) data collection on the job under study

Group Assignment* for Supplement F

(all due on the last day of this week's classes)

1. Using either the time study or work sampling methods as described in this supplement, perform an analysis of a (TNB) job. Present your results in a ten-minute PowerPoint® presentation (which should be supported with appropriate* documentation).
2. Solve* Text Problems 4, 6, 8 and 10 on text pages 230-231.

* Solutions should be submitted in the form of a ***coherent and concise*** report -- something that top management can assimilate quickly!

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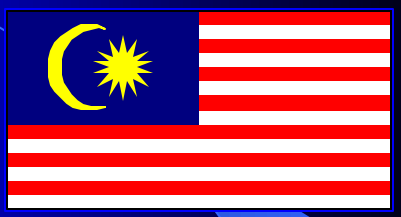

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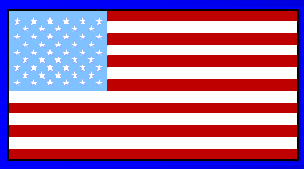

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