Direct Time Study

Chapter 13

Sections:
1. Direct Time Study Procedure
2. Number of Work Cycles to be Timed
3. Performance Rating
4. Time Study Equipment

Direct Time Study - Defined

- Also known as "stopwatch time study"
- **Direct and continuous observation** of a task using a stopwatch or other timekeeping device to record the time taken to accomplish the task
- While observing and recording the time, an appraisal of the worker's performance level is made to obtain the normal time for the task
- The data are then used to compute a **standard time** for the task after adding the PFD allowances
- It is much more appropriate for **repetitive tasks** (batch and mass production)
Direct Time Study Procedure

1. Define and document the standard method
2. Divide the task into work elements
   - Steps 3&4 are performed simultaneously, several times.
3. Time the work elements to obtain the observed time \( T_{obs} \)
4. Evaluate worker’s pace relative to standard performance to obtain normal time \( T_n \)
   - Called performance rating (PR)
     \[ T_n = T_{obs}(PR) \]
   - Then the values collected in steps 3 and 4 are averaged.
5. Apply allowance factor to compute standard time
   \[ T_{std} = T_n(1 + A_{pfd}) \]

1- Document the Standard Method

- **We first start with** methods engineering study: determine the “one best method”
  - Seek worker’s advice if possible

- **Documentation should include:**
  - All of the steps in the method (hand & body motions)
  - Special tools, gauges, equipment and equipment settings (e.g., feeds and speeds) if applicable
  - workplace layout, working conditions, even a videotape of the method
  - Irregular elements and their frequency
  - You should guarantee that all the items given above are standardized
2- Divide Task into Work Elements

- **Work element** is a series of motion activities that are grouped logically together
- Has a unified purpose in the task

**Guidelines for defining the work elements** (see page 346):

- Each work element should consist of a logical group of motion elements
- Beginning point of one element should be the end point of the preceding element
- Each element should have a readily identifiable end point
- Separate irregular elements (non-frequent element) from regular elements
- Separate manual elements from machine elements
- Separate internal elements (during machine work) from external elements
3- Time the Work Elements

- Each element should be timed over several work cycles to obtain a reliable average

- **Stopwatch timing methods:**
  1. **Snapback timing method** – Flyback – stopwatch is reset to zero at the start of each work element
  2. **Continuous timing method** – stopwatch is allowed to run continuously throughout the duration of the work cycle

Advantages of Each Timing Method

- **Advantages of snapback method:**
  - Analyst can readily see how element times vary from cycle to cycle
  - No subtraction necessary to obtain individual element times

- **Advantages of continuous method:**
  - Elements cannot be omitted by mistake
  - Regular and irregular elements can be more readily distinguished
  - Manipulation and resetting of the stopwatch is reduced

---

7

---

8
4- Performance Rating

- Analyst judges the performance or pace of the worker relative to the definition of standard performance used by the organization.

- Standard (normal) performance $PR = 100\%$ (Standard)
  - Slower pace than standard $PR < 100\%$ (poorer performance)
  - Faster pace than standard $PR > 100\%$ (Better performance)

- Normal time $T_n = T_{obs}(PR)$
Performance Rating (leveling)

- Most common performance rating method is based on speed or pace.
- Elemental rating vs. overall rating
  - If the work cycle is relatively short (less than 1 minute) and the work content is similar throughout the cycle, then rating the entire cycle (overall rating) makes sense.
  - Otherwise elemental rating is more appropriate.

Characteristics of a Good Rating System

- Consistency among tasks
- Consistency among analysts
- Easy to explain and easy to understand
- Based on a well-defined concept of standard performance
- Observe several cycles and different workers before rating
- Rate performance during the observation
- Worker notification
5- Apply Allowances

- A PFD allowance is added to the normal time to compute the standard time

\[ T_{std} = T_n (1 + A_{pfd}) \]

where \( A_{pfd} \) = allowance factor for personal time, fatigue, and delays

- The function of the allowance factor is to inflate the value of standard time in order to account for the various reasons why the worker loses time during the shift

Example 1

- Given: A direct time study was taken on a manual work element using the snapback method. The regular cycle consisted of three elements, a, b, and c. Element d is an irregular element performed every five cycles.

  Work element | a | b | c | d
  -------------|---|---|---|---
  Observed time (min) | 0.56 | 0.25 | 0.50 | 1.10
  Performance rating | 100% | 80% | 110% | 100%

- Determine

  (a) normal time
  (b) standard time for the cycle using \( A_{pfd} = 0.15 \)

Solution

(a) Normal time:

\[ T_n = 0.56(1.00) + 0.25(0.80) + 0.50(1.10) + 1.10(1.0)/5 = 1.53 \text{ min} \]

(b) Standard time:

\[ T_{std} = 1.53(1 + 0.15) = 1.76 \text{ min} \]
Cycle-to-Cycle Time Variations

Result from the following:
1. Variations in hand and body motions
2. Variation in the placement of parts and tools
3. Variations in the quality of the starting work units
4. Operator mistakes
5. Timing errors by analyst
6. Variations in worker pace

Number of Cycles to be Timed

Let $T_e$ = work element time
$x$ = individual values of observed times collected during the study
$\bar{x}$ = observed average value of the element time
$n$: number of observations of an element that are needed
$k$: acceptable fraction of $x$-bar

Objective: Identify the true value of $T_e$ within a certain confidence interval.
We want to be $100(1-\alpha)\%$ confident that $T_e$ lies within $\pm10\%$ of $T_e$.

After several cycles, calculate sample standard deviation $s$

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

Using the Student t distribution,

$$n = \left( \frac{t_{\alpha/2} s}{k \bar{x}} \right)^2$$
Example 3

A time study analyst has collected 10 readings on a particular work element of interest and would like to consider how many more cycles to time. Based on the sample, the mean time for the elements is 0.40 min and the sample standard deviation is 0.07 min. At a 95% confidence level, how many cycles should be timed to ensure the actual element time is within ± 10% of the mean?

Example: solution

We have 10 - 1 = 9 degrees of freedom in the t distribution, t_{95} at the 95% confidence level (α/2 = 0.025) is 2.262.

\[ n = \left( \frac{t_{\alpha/2} \cdot s}{k \cdot \bar{x}} \right)^2 \]

\[ n = \left( \frac{2.262(0.07)}{(0.1)(0.40)} \right)^2 = 15.7 \approx 16 \]

Since 10 cycles have already been timed, the analyst needs data from 6 more cycles.
Characteristics of a Good Rating System

- Consistency among tasks
  - A worker who can perform at 125% on one task should be able to do the same on other tasks
- Consistency among analysts
- Easy to explain and easy to understand
- Based on a well-defined concept of standard performance
- Observe several cycles and different workers before rating
- Rate performance during the observation
- Worker notification

4. Time Study Equipment

1. Stopwatch
   - Mechanical stopwatches
   - Electronic stopwatches
   - Scales
     1. Decimal minutes
     2. Decimal hours

2. Video cameras
   - Provides visual and audio record of method used by worker

3. Computerized techniques in direct time study
   - Use of PCs and PDAs
   
   With this PDA, you can study elements, time, performance rate, and statistical confidence intervals can be created, edited, managed, and downloaded to a spreadsheet