INDUSTRIAL ENGINEERING

Lesson 6:
Work Measurement

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Synopsis

In this chapter, the general concept of work measurement will be discussed comprising standard time and work measurement techniques.

Expected Outcome

1. Understand the concept of work measurement and standard time.
2. Apply the methods of determining standard time.
3. Apply work measurement techniques.

Work Study

Methods Study

To improve methods of production

To determine the best way to complete a repetitive task

Resulting in more effective use of material, manpower, machine & equipment

Work Measurement

To assess human effectiveness

To measure how long it takes to complete a task at a normal pace.

Making possible improved planning & control, & as a basis for a sound incentive scheme

Higher Productivity

What is Work Measurement?

It is frequently called as time study to assess the time allowed to perform a task.

Objectives of Work Measurement

- ✓ To determine a standard time
- ✓ To determine manpower requirements & capacity limitations.
- ✓ To compare alternative methods for accomplishing the same task.
- ✓ As a basis for worker performance evaluation.

What is standard time?

The time allowed for worker to process 1 unit using the standard method & working at a normal speed.

Pre-requisite for a Valid Standard Time

1. The task is done by an average qualified worker

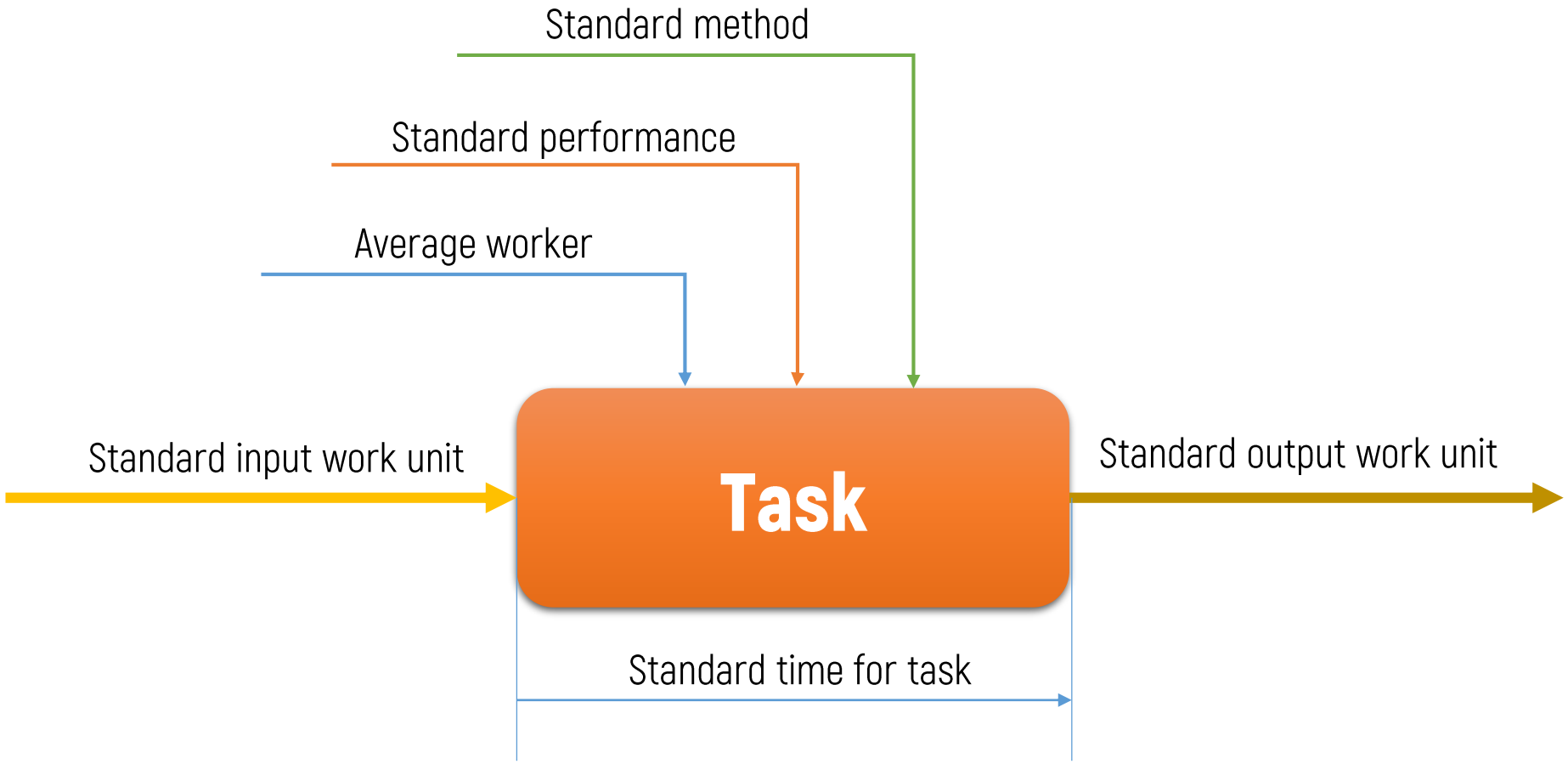
2. The worker's pace (speed) represents standard performance

All the 4 factors must be standardized

3. The worker uses the standard method

4. The task is done on a standard output unit

Pre-requisite for a Valid Standard Time



Methods to Determine Standard Time

Estimation

Based on judgement from foreman, supervisor or those who are familiar with the jobs.

Historical records of previous production run

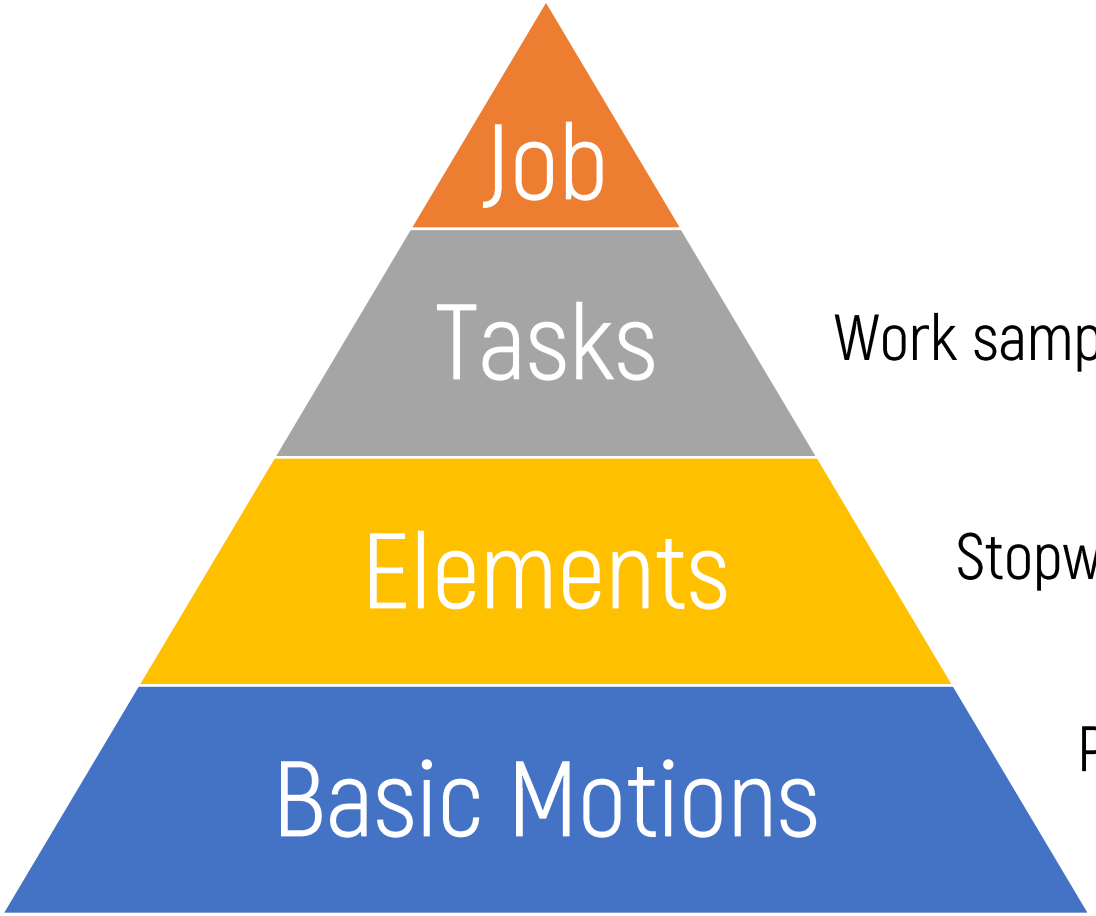
Based on the actual times recorded from previous job orders.

Methods to Determine Standard Time

Work Measurement (WM) techniques

- ✓ **Direct WM**: Stopwatch Time Study (STS), Work Sampling (WS)
- ✓ **Indirect WM**: Predetermined Motion Time Systems (PMTS), Standard Data System (SDS).

Pyramidal Structure of Work & WM Techniques

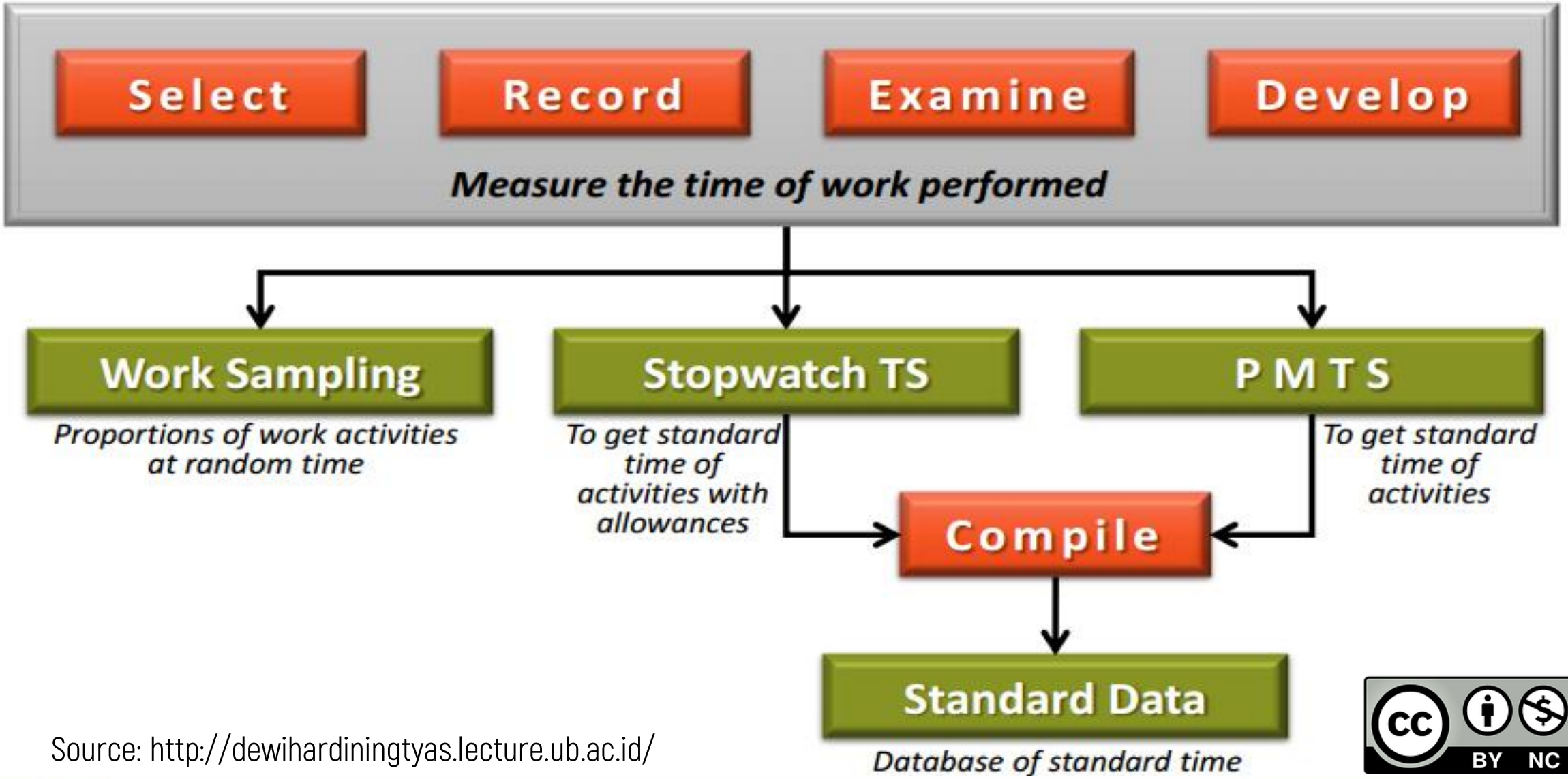


Work sampling

Stopwatch TS, Standard data

Predetermined motion time system (PMTS)

WM Techniques



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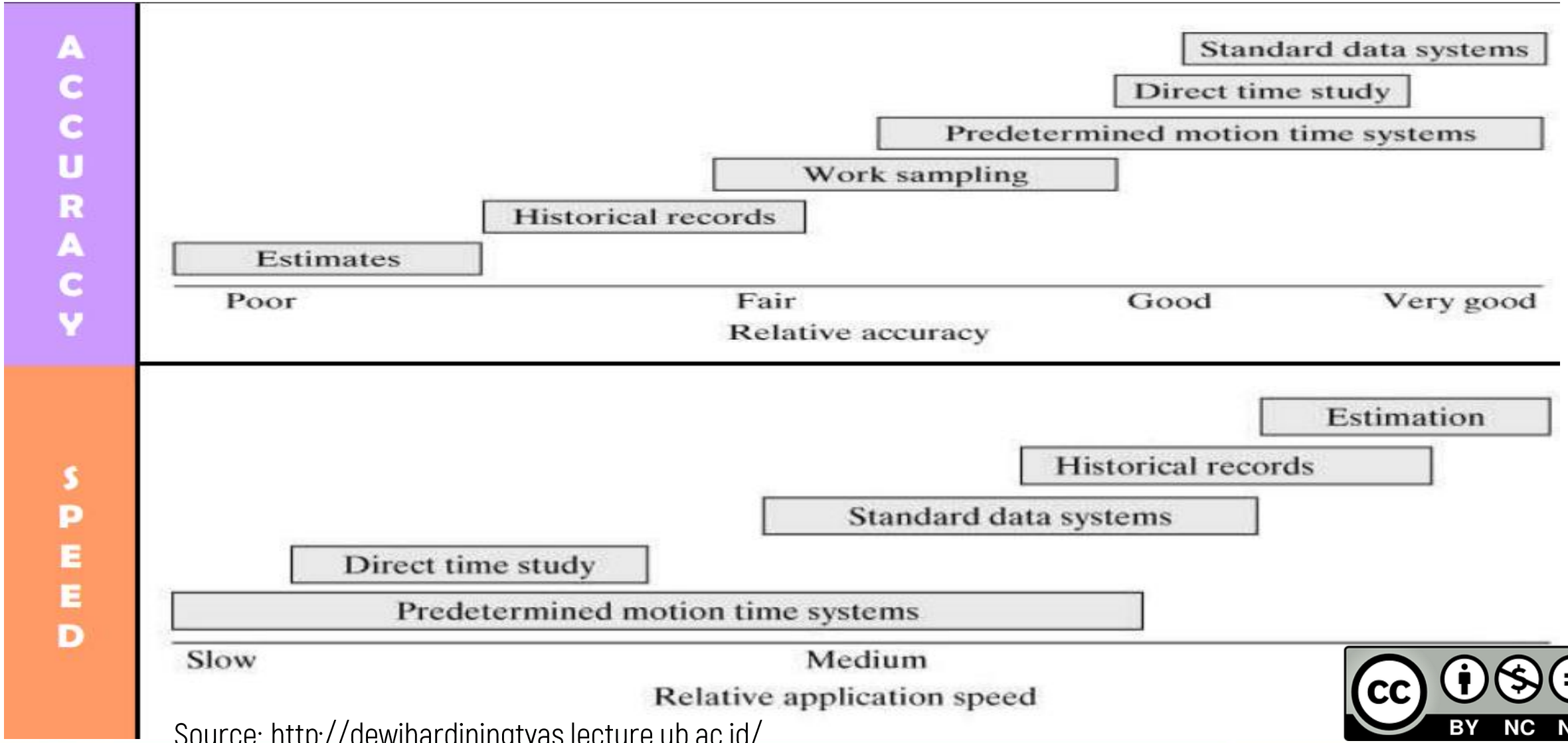
Comparison Among the WM Techniques



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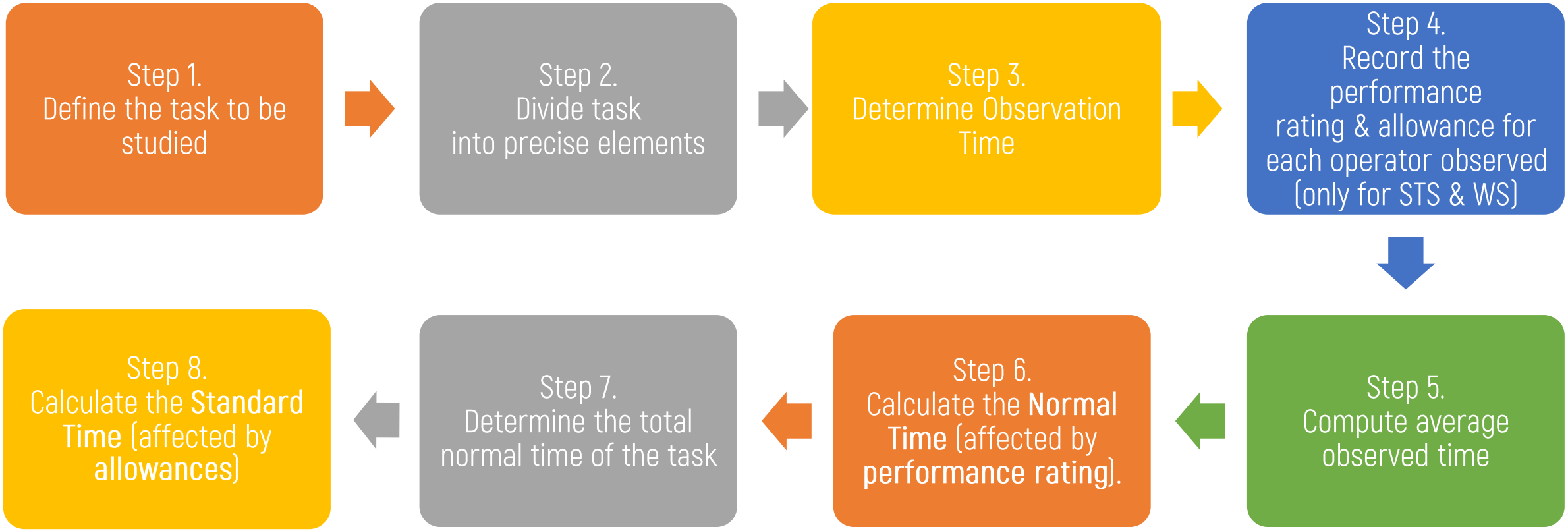
Steps in Determining Standard Time



Determining Standard Time

Step 5: Calculate average actual time.

$$\text{Average observed time} = \frac{\left[\text{Sum of the times recorded to perform each element}\right]}{\text{Number of observations}}$$

Step 6: Calculate performance rating & compute the normal time.

$$\text{Normal time} = \left[\text{Average observed time}\right] \times \left[\text{Performance rating factor}\right]$$

Performance Rating

It is 'adjustment' to the mean observed time to arrive at the time that the normal operator would have taken.

Performance Rating

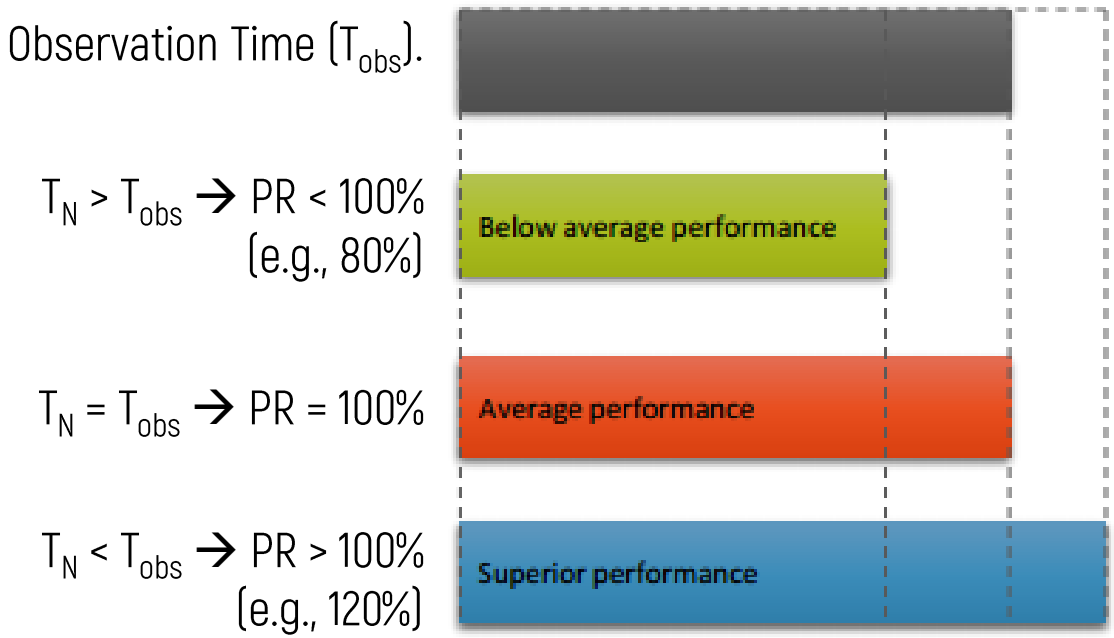
Performance rating is determined based on the experience & judgment of the observer.

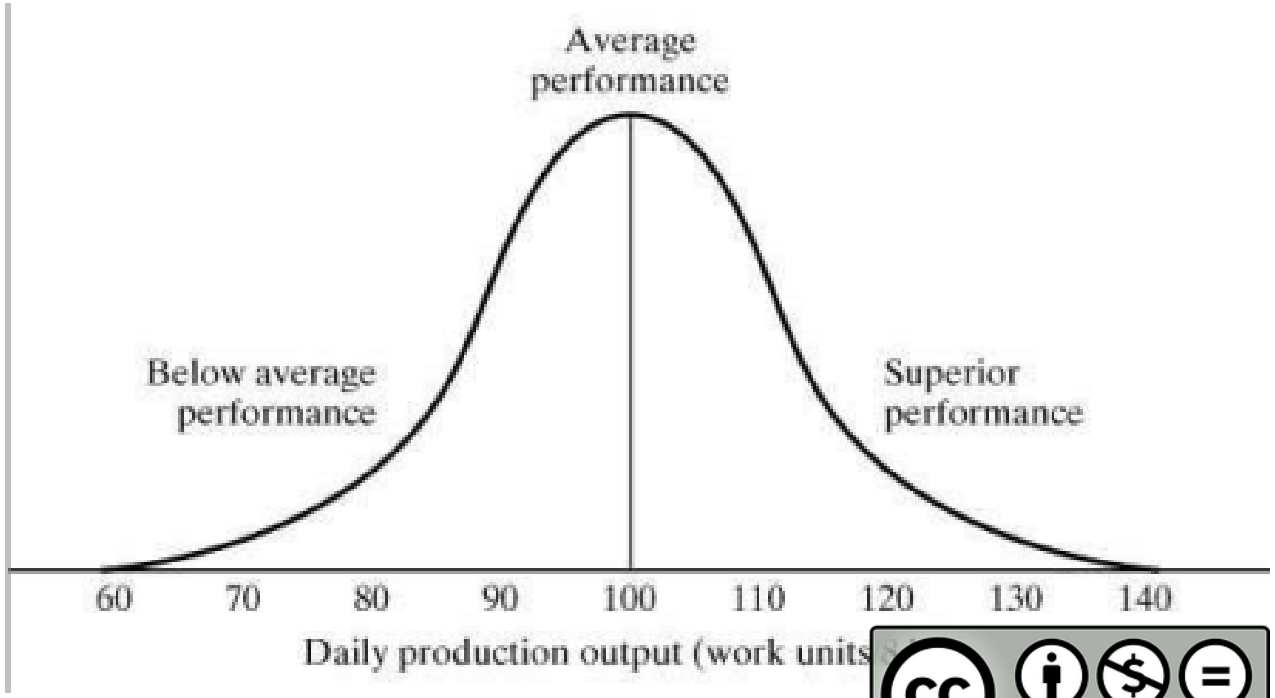
$$\text{Rating Factor} = \frac{\text{Observed Performance}}{\text{Normal Performance}}$$

Determining Performance Rating

Pace (speed) rating method

Observer judges the operator's speed of movements.





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Determining Performance Rating

Westinghouse Rating Method

It considers 4 factors: skill, effort, conditions, & consistency.

Skill		Effort	
+ 0.15 A_1 - Superskill	- 0.05 E_1 - Fair	+ 0.13 A_1 - Excessive	- 0.04 E_1 - Fair
+0.13 A_2	- 0.10 E_2	+ 0.12 A_2	- 0.08 E_2
+0.11 B_1 - Excellent	- 0.16 F_1 - Poor	+ 0.10 B_1 - Excellent	- 0.12 F_1 - Poor
+0.08 B_2	- 0.22 F_2	+ 0.08 B_2	- 0.17 F_2
+0.06 C_1 - Good		+ 0.05 C_1 - Good	
+0.03 C_2		+ 0.02 C_2	
0.00 D - Average		0.00 D - Average	

Conditions		Consistency	
+ 0.06	A - Ideal	+ 0.04	A - Perfect
+ 0.04	B - Excellent	+ 0.03	B - Excellent
+ 0.02	C - Good	+ 0.01	C - Good
0.00	D - Average	0.00	D - Average
- 0.03	E - Fair	- 0.02	E - Fair
- 0.07	F - Poor	- 0.04	F - Poor

Source: http://dewihardiningtyas.lecture.ub.ac.id/

Determining Standard Time

Step 8: Compute the standard time.

$$\text{Standard time} = \frac{\text{Total normal time}}{1 - \text{Allowance factor}}$$

Allowance Factors

- Personal time allowance
- Delay allowance
- Fatigue allowance

Allowance Factors (%) for Various Classes of Work

1. Constant allowances:
   - (A) Personal allowance 5
   - (B) Basic fatigue allowance 4
2. Variable allowances:
   - (A) Standing allowance 2
   - (B) Abnormal position allowance:
     - (i) Awkward (bending) 2
     - (ii) Very awkward (lying, stretching) 7
   - (C) Use of force or muscular energy in lifting, pulling, pushing

     Weight lifted (pounds):
     - 20 3
     - 40 9
     - 60 17
   - (D) Bad light:
     - (i) Well below recommended 2
     - (ii) Quite inadequate 5
   - (E) Atmospheric conditions (heat and humidity):

     Variable 0–10
   - (F) Close attention:
     - (i) Fine or exacting 2
     - (ii) Very fine or very exacting 5
   - (G) Noise level:
     - (i) Intermittent—loud 2
     - (ii) Intermittent—very loud or high pitched 5
   - (H) Mental strain:
     - (i) Complex or wide span of attention 4
     - (ii) Very complex 8
   - (I) Tediousness:
     - (i) Tedious 2
     - (ii) Very tedious 5

Source: Heizer & Render, 2014

Determining Sample Size

Time study requires a sampling process, so sampling error must be considered.

Sampling error differs contrariwise with sample size.

Determining Sample Size

$$Required\ Sample\ Size = n = \left(\frac{zs}{h\bar{x}}\right)^2$$

Where,

h = Acceptable error desired (e.g., 5% = 0.05)

z = standard deviations (90% confidence = 1.65, refer to z value table)

s = standard deviation of the observation

$\bar{x}$ = average of the observation

Source: Heizer & Render, 2014

Determining Sample Size

Common z values (i.e., standard deviations required for the desired level of confidence)

Desired confidence (%)	z-value
90	1.65
95	1.96
95.45	2.00
99	2.58
99.73	3.00

Source: Heizer & Render, 2014

Determining Sample Size

If desired accuracy *h* is expressed as an absolute amount (*e*), substitute *e* for $h\bar{x}$, where *e* is the absolute amount of acceptable error.

$$Required\ sample\ size\ (n) = \left(\frac{zs}{e}\right)^2$$

When the standard deviation *s* is not provided, it must be computed.

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

x_i= value of each observation

$\bar{x}$ = mean of the observations

n = number of observations in sample

Source: Heizer & Render, 2014

Work Sampling

Step 1: Take a sample to obtain parameter values.

Step 2: Compute the minimum sample size for a given confidence level & accuracy.

$$Required\ sample\ size = n = \frac{z^2 p(1-p)}{h^2}$$

z = standard deviation for the desired confidence level (based on normal table).

p = estimated value of sample proportion (of time worker is observed busy or idle).

h = acceptable error (%).

Procedure of Work Sampling

Step 3: Use random number to prepare a schedule for random observations.

Example: From the table of random number, we draw the following five random numbers: 7, 12, 22, 25, 34. Thus, observation schedule will be 9:07, 9:12, 9:22, 9:25, 9:34.

Step 4: Observe & record employee's activities.

Step 5: Determine how employee spend their time.

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