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Methodology Selecting Work Time Measurement Methods: A Guide Model for Maintenance

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***Abstract*— Getting standard time is rarely based on standard work conditions. Looking for maintenance non-productive activity time is not an easy task because many uncontrollable parameters involve in the task processes. Also there are many work time measurement methods, but choosing one among them should be responding to each real work context which is always variable and evolutive. Working measurement is analyzed here and a justified initiative guideline is proposed for helping choosing convenient time measurement methods according to each or cumulative job situations. Illustrations in maintenance cases are outlined. Such information is very valuable for a good look-ahead planning and scheduling as far as deducting of work reference time and work management are concerned.**

Keywords*— work study, time measurement methods, working methods, maintenance

I. INTRODUCTION

When we tock about work study, we are expecting defining the appropriate time for a particular task. In this regard, each initiative for computing task time is a welcome issue. There are quite many time measurement methods in the literature, but we are sometime confuse which method can help collecting appropriate or let us say standard task time. So, the best appropriate time measurement method will be chosen according to the magnitude of each activity, though there are various variant and evolutive factors which are not always consider in the time measurement method.

Timing a manual activity is not only narrowly link to movement of object as related **[1],** but also to the quality of manual output and security of the worker while performing the task. For example in the case of maintenance activities, maintenance actor has his own experience level and should spend adequate time to perform a task while thinking of optimal equipment refunctioning. So, there is no working speed in such case. Timing a job is not an easy task, especially when recording standard time is needful precisely in the competitive sector.

Suppose an organization wishes to manufacture a new product. Knowing how much time it takes to perform certain tasks enables manager to achieve and maintain a high utilization of personnel, material and equipment. This results in an overall efficiency that will make sustainable organizational growth possible. There are many reasons for wanting to know the amount of time a particular task should take to be completed. It may simply be for reasons of curiosity. But realistically, it is for any of three reasons **[2]:**

-To accomplish planning,
-Determine performance and measure the length of a working cycle
-Establish costs.

Collecting standard task time is really difficult as I mention previously. It has been proved that it is not an easy task to standardize task time in certain activity domain due to not only the variant nature of working methods but also to variant human experienced and variant time measurement tools. Some difficulties like social and technical barriers for measuring work time have been related by **[3].** Also principles of selecting appropriate measurement methods for specific situations in industrial practice have been discussed according to **[4],** but these remain insufficient due to wide type of labor activities. How then can we choose an appropriate time measurement methods for a particular work method in a specific context? Isn't really difficult to standardize task time knowing variant variety types of activity and human experience?

Following these questions, we tried to formulate some rule of thumbs for easy choosing the appropriate time measurement methods based on real diverse work situation, description, and context. Another goal here was to reiterate the description of the complex nature and variant task types. These analysis gathered from reading adequate scientific relate paper, but also come from our personal experiences with mechanical technic.

Through brief description of each work time measurement methods, their strengths and weaknesses, we closed this reflection by a framework guideline selecting convenient time measurement methods for each well-defined case of automobile maintenance study.

II. BRIEF DESCRIPTION REVIEW OF WORK TIME MEASUREMENT METHODS

Work measurement is a systematic procedure for the analysis of work and determination of time required to perform key tasks in processes. It is typically based on time standards for manual tasks. Literature mentioned quite detail time measurement methods (Advanced Time study, Work sampling, Working day's activity study, Work factor, MTM and MOST) which are sometimes based on industrial (so call custom, high skill labor by [3]) and non-industrial labor.

Considering a practical perspective, the methods of research in time in assembly processes performed by workers have been evaluated i. e. time study, working day's activity study, MTM, MOST and Work-Factor during assembly of a milling machine spindle in JAFO S.A. factory [4].

Brief descriptions of those methods are presented below:

A. Advanced Time Study

Time study is a technique to estimate the time to be allowed to a qualified and well-trained worker working at a normal pace to complete a specified task by using specified method. This technique is based on measuring the work content of the task when performed by the prescribed method, with the allowance for fatigue and for personal and unavoidable delays. Divide the operation into reasonably small elements, and record these on the Time Study observation sheet multiply it by the rating factor to get normal time **[5]**.

$$Normal\ Time = Observed\ Time \times Rating\ \ Factor \quad (1)$$

Determine allowances for fatigue and various delays. Determine standard time of operation by adding allowances in normal time i.e.

$$S\tan dard\ Time = Normal\ Time + Allowances \quad (2)$$

There is now technological up-to-date stop watcher available with easy collecting and computing task time. So, time study method becomes also accurate like other time recording methods.

B. Work sampling

While using the latest technology to improve the time study process decreases the amount of effort it take to collect data, observers still have to watch the entire process multiple times to develop times estimates. Work sample is a common method of work measurement that, when used correctly, can eliminate the need to watch the custom job from start to finish. Work sample involve taking instantaneously observations of a job at separate points along its timeline. At each observation the observer picks which steps an employee is doing from a predetermined list of possible tasks. The great advantage here is that work sampling observation size is small.

C. Working day's activity study

Working day's activity study is a method based on constant observation and measurements of time used by a worker at a work station, including duration of actual work and breaks. The objective of this method is to calculate standard times on the basis of times actually utilized.

D. Work factor

Work factor is based on classification of human movement taking into account four basic factors: a part of the body involve in the movement, path of the movement, loads connected with the movement and level of worker's mastery. The predetermined codes have been already depicted in the literature.

E. MTM

The release of the Methods Time Measurement (MTM) system in the 1940s was an important step forward in predictive work measurement. It is defined as `a procedure which analyses any manual operation or method into the basic motions required performing it. MTM assigns to each motion a predetermined time standard which is determined by the nature of the motion and the conditions under which it is made **[6].**

One of the major problems in applying MTM to manufacturing operations is that it is extremely tedious and time consuming, since a work analyst must observe and document each movement in great detail. In addition, such an approach generates large amounts of data which must be managed.

There are three main groups of motions in this method: 9 hand movements, 2 eye movements and 15 body and leg movements. Within the first group, the movements are divided into categories. In some cases, depending on their character and condition of performance, the categories are father divided into classes. The categories and classes of movements have relevant times assigned (in tables) with the basic time measurement unit (TMU) being equal 0.0006 min. in order to use this method in practice it is necessary to have qualified workers, with proper theoretical training and extensive practical experience.

F. MOST

The development and release of the MOST (Maynard Operation Sequence Technique) in the 1960s alleviated many of MTM problems, since it is much simpler and more efficient. It classifies all human movements into three basic categories, and the description of each category is done by assigning values to only a few standard parameters. It is the latest work measurement technique that can be easily implemented and practically maintained to not only estimate the standard time but also improve methods and maximize the resource utilization **[1]**.

The predetermined time study forms the basis for the MOST work measurement technique **[7].** They pointed out that estimating methods cannot determine accurate times; hence MOST is a standard method to determine the potential error which helps in minimizing the time taken to perform a task or operation. MOST makes the measurement of work a practical, efficient, and inexpensive task for the industrial engineer

There are different types of MOST system: MiniMOST, BasicMOST, MaxiMOST, clericalMOST and AdminMOST

For example the BasicMOST focuses on three types of object movements.

The Basic MOST work measurement technique therefore comprises the following sequence models: (see table 1 below.)

TABLE I: The Basic MOST System **[1]**

Activity sequence	Sequences description	Metric meaning
General Move sequence	A B G A B P A Get Put Return	A = Action distance B = Body motion G = Gain control P = Placement
Control Move sequence	A B G – M X I – A Get Move Return	M – Move Controlled X – Process Time or Actuate I – Alignment
Use tool sequence	ABG-ABP- *- ABP- A Get Put Use tool	F-Fasten L- Loosen C- Cut S- Surface treat M-Measure R- Record T- Think

III. MTHODOLOGY APPRROACH FOR COLLECTING ACTIVITY TIME

The initiation of timing a job should be the decision of the enterprise manager, because the timing process is not an easy issue according to each time measurement tool. So getting standard time for a particular task should be well –defined and clear. The process encompasses many factors that need a deep analysis at each stage. So the figure below shows the steps of analyzing the timing process.

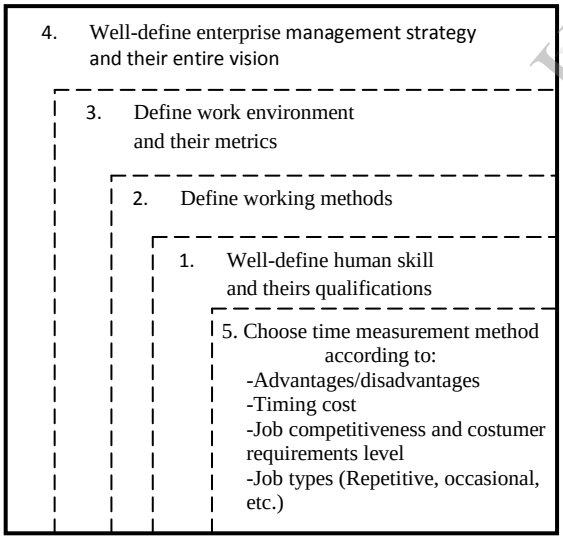

Fig. 1: recommended steps for looking for task timing methods

IV. ANALYSIS RESULTS OF SELECTING CONVENIENT TASK TIME MEASUREMENT METHOD

A review of presented methods is made and their strength and weaknesses are discussed. At the end principles of selecting appropriate methods for specific situations in industrial practice are presented.

A. Strenght and weanesses for each method

These tables below compile a full range of work situation description that should be strengths or weaknesses according to each time measurement tools. This can help scientist having a look to their precise decision while facing tool selection and timing a job.

The comparative strength (table 2) and weakness (table 3) of each industrial context and their specific need is presented below. Each measurement method is more prominent for a particular and practical industrial job context than other. We are now struggling understanding which method should be chosen when timing a job according to their comparative strengths and weaknesses.

Appreciation scale:

Very weak relation (-)
Weak relation (x)
Forte relation (xx)
Very forte relation (xxx)

Table 2 and table 3 close at the end of this paper are really illustrative.

Anywhere looking for reducing ineffective time can be possible by some management act as follow:

- Better layout and process planning reduces unnecessary movements;
- Materials handling adapted to activity reduces time and effort;
- Methods study of an activity reduce work content due to poor method of work;
- Proper management and personal policy can create a satisfying working environment;
- Training can develop appropriate skills;
- Better working conditions improves morale and reduces absenteeism.

Implementing these above actions might be strengthened the entire work conditions.

B. Classification of tool according to their practical requirements and common related philosophy

TABLE IV: Group of timing tool and their practical requirements

Time measurement tools	Requirements
Predetermined tools : Work factors, MTM and MOST **(Group A)**	work time observer should be trained Need experienced observer Software method computing time is needed
Advanced Time Study, Working Sample **(Group B)**	Good for long and constant observation Software method computing time is needed Good for measuring heavy task
Working day's activity study **(Group C)**	Common skill trained observer Even poor observation technique is sufficient Traditional and manual computing methods
Any of them	The visual environment should be well lit, clean and uncluttered, allowing good depth perception and discrimination of visual details; The thermal environment should be within zones of comfort for the physical work (18-20 °C); The acoustic environment should be agreeable, with sound levels preferable below 75dBA; Good housekeeping helps to avoid injuries; Written instructions and labels should be made available whenever necessary; Layout of the overall work facility.

Instead of having six types of time measurement methods, one can regroup it in three categories according to their common philosophy. There is similarity requirements for each grouped time measurement methods.

C. Methodology selecting time measurement tools

Let's present this methodology in the context of maintenance activity. Maintenance has the mission of restoring the refunctioning condition of the default equipment. When failure occurs, maintenance actor has to take an adequate time for intervention. This time is a function of many parameters according to the each work environment and conditions. Timing a task in such context necessitates the study of work environment. That's why choose a time measurement method for timing a task is profoundly based on work factors like: worker factors, environment factors, management factors and task types.

The figure 2 below presents the activities and their entire environment factors which the major of it should be consider.

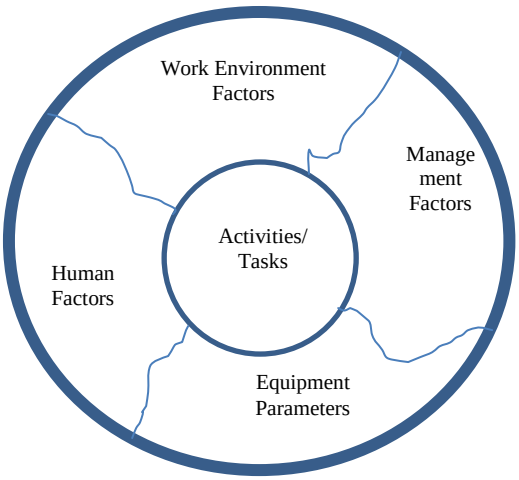

Fig. 2: work content

Choosing a time measurement method should start by defining enterprise management strategy and vision, followed by defining work environment and methods, and ended by defining human skill and their qualification. When all the precedence factors are clear, knowing the task nature, one can easily appreciate each work factors level as states the table 5 below. This table is filling according to the automobile maintenance context taken here as a filling model.

For filling this table 5, one can assume that all types of work listed below in the first column are sometimes performing in the firm. So, each work factors level should be appreciated with the scale high, average or low according to the real context of the work. This table can be held for any initiative of choosing work time measurement method of all type of job if such job has been profoundly studied and divided into reasonably small elements.

TABLE VI: Appreciation scale

Scale	**Meaning** (appreciation according to each job requirements level)
High	Outstanding work factors level
Average	Approximative wok factors level
Low	Poor work factors level

Those who initiate filling this table 5 are supposed to be qualified in their field. Any factor should be appreciated by high, average or low according to each real work context and nature. The first filled column in red color is an example how to fulfill the table and his related group is Group B. So, for any work type, one can choose an adequate time measurement method according to the real overall performance factors.

CONCLUSION

As one of the strategies of choosing work time measurement method, rapid and comprehensive model of selecting work time measurement method have been highlighted. Each activity is performed in a particular context and condition and need to be study carefully before deciding which measurement tool should be held for working measurement process. So a concise analysis of the major work time measurement methods has been illustrated and one can easily follow the proposed selection model in alignment with the proper work environment context, because there is no standard work condition. This model is flexible according to the context. This is useful when job competitiveness is in sight so that performance can be appreciated for better scheduling and maintenance organization. It has also been observed that for a single activity more than one type of work time measurement method can be used for timing.

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TABLE II: Comparative strengths appreciation for time measurement methods

Specific context (Strength descriptions)	Time measurement methods					
	Advanced Time study	***MTM***	***MOST***	***Work factor***	***Working day's activity study***	***Work sampling***
-Very precise reproduction of duration of activities (trustworthiness)	xxx	xx	xx	-	-	x
- Credibility of means values used for determining time allowances	xx	xx	xxx	x	-	xxx
- Precise recording of events of the basis of information coming from trustworthy sources (reliability)	xxx	xx	xxx	xx	xx	xx
-Acceleration and simplification of data preparation, so that the can be used in decision making processes	xx	xx	xxx	xx	x	xxx
- One person can carry out measurements of up to six workstations	xx	xxx	xxx	xxx	xxx	xxx
-Precise recording of all events (duration of employee's breaks and actual work)	-	-	-	-	xxx	x
- Recording individual standard times taking into account factors which influence them	xx	xx	xx	xxx	x	x
- Improvement in existing methods, procedures, constituting additional aid and materials for designing new procedures.	xx	xx	xx	xx	x	x
- Obtaining standardized time consumption in logical sequence, with suggestions for standard performances times	xx	xxx	xxx	xx	x	xx
- Possibility to develop various variants of the execution of the given work	xx	xx	xx	xx	-	-
- Possibility to design a manufacturing process which is more economically under given production conditions, in particular prior to launching production of the product	x	x	xx	xx	-	-
-…….						

TABLE III: Comparative weaknesses appreciation for time measurement methods

Specific context (Weakness descriptions)	Time measurement methods					
	Advanced Time study	***MTM***	***MOST***	***Work factor***	***Working day's activity study***	***Work sampling***
- Time consuming nature of measurements	x	x	x	x	xxx	xx
- Highs costs of measurements	xx	xx	xx	xx	xxx	xx
- Constant concentration of the part of the person performing stopwatch measurements	xx	x	xx	x	x	x
-Disregard for the random nature of recording actual times	x	xxx	xxx	x	xxx	x
- Possibility of inflating task duration by the worker	-	-	-	x	xxx	x
-Limited possibility to analyze the methods and work of white-collar workers and person working with machinery and equipment; improvements and measurements of slow-tempo-work (non-repetitive tasks, low volume or individual production)	-	-	-	-	xx	-
- Necessity to provide users with full-time theoretical and practical training	-	-	-	-	x	xxx
-……						

TABLE V: Choosing adequate time measurement method based on task types

Task nature and their metrics		**Worker factors**			**Environment factors**		**Management factors**			**Appropriate time measurement methods**
		Experience level	***Force / velocity level***	***Endurance level***	***Ergonomical infrastructure and tools level***	***Working conditions level***	***Personal motivation level***	***Prescribed work method level***	***Upgrade training and personal policy level***	
Repetitive work	Long cycle and various variant sequence	**High**	High	High	High	High	High	**High**	High	**Group B**
		Average	**Average**	**Average**	**Average**	Average	**Average**	Average	**Average**	
		Low	Low	Low	Low	**Low**	Low	Low	Low	
	Short cycle and non-various variant sequence									
Occasional work	Long cycle and various variant sequence									
	Short cycle and non-various variant sequence									
Complex work	Uncommon technology and job									
	Long cycle and various variant sequence									
Intellectual work	common thinking									
	Selective, prominent and outstanding thinking									
Time-keeping work	Constant observation									
	relaxed observation									