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First Step In Increasing Productivity: Work Sampling

[1,]A.Aslı İlleez, [2,]Serpil Kaya[2]
[1,2,]*(Emel Akın Vocational School,Ege University,Turkey)*

ABSTRACT : *Increasing competition with globalization has made it necessary to make various improvements in the apparel sector like every sector. The production times need to be examined in order to reduce the costs and thus increase the productivity. The most effective method to do this systematically is to use work-study methods. Beginning of improvement work without detecting the problem exactly can lead to wrong results. For this reason, when starting to work on improvement, it is necessary to start with "work sampling" method of work study. In this study, an application has been made about improving the standard unit time in the sewing section when operating a garment. During the study, the work sampling method was used to determine the idle times, known as out-of-work durations, during the study of the people in the production. Suggestions on productivity studies were made by looking at the results obtained after the work sampling studies.*

KEYWORDS : *Idle time, Productivity, Sewing, Work Sampling,*

I. INTRODUCTION

Efficiency is one of the most important sources in the long run not only for the success of organizations and individuals but also for national economy and social development. Companies must use the resources they have (personnel, machinery, materials) effectively. For this reason, automation is increasing day by day in the use of production tools and human resources employment has become inevitable for many companies. Businesses have to take into account the delays and lost times that occur during production and to measure their limits in order to increase productivity. Many productivity enhancing methods have been developed to avoid the negative consequences of low productivity. There are a variety and a wide range of techniques. Work study technique is one of these techniques. A work study is a general term used for method study and work measurement techniques, especially for method study and work measurement techniques, which investigates all the factors affecting a particular event or activity in terms of cost and effectiveness in order to create development opportunities and broadly examines human work. In this method, people's work is examined and the factors affecting the efficiency are determined [1].

The aim of time study is to establish a time for a qualified worker to perform specified work under stated conditions and at a defined rate of working. With time study, it is possible to determine the ineffective time spent during the execution of a process and thus the actual time spent for work can be determined [1]. Continuous or all-day time study; is the most common method used to obtain precise information about a worker, machine, or material process. Such a time study requires that the examiner observes the worker or machine for the whole day or the working period, and the time and the duration of the work done and the delays must be determined and recorded. Continuous work surveys are laborious and costly, as well as work when neither the study nor the analyst is more willing to make it happen, especially when spread over a long period of time. However, management generally needs the kind of information that such studies will provide.
The work sampling method allows the analyst to make random observations on the worker or the machine and obtain similar information without using any measuring tool. Likewise, under certain conditions, time standards can be determined by sampling. Because of these features, businesses often resort to the business sample first to gain insight into the existence and rate of time loss and thus to assess the effectiveness of management and decide whether a more detailed study is needed in the future [1]. In this study, a preliminary study on productivity analysis was carried out for the production departments of a company operating in İzmir provincial borders and producing male suits. The work sampling method was used as a decision-making tool in the study conducted to determine whether detailed efficiency analysis is needed.

II. LITERATURE REVIEW

Work sampling was first conducted in 1935 by a British statistician L.H.C. Developed by Tippett. At that time, this method was only used to measure the non-production times of machines, but today it is also used to identify and remedy the causes of inactivity of persons and machines [2]. Although the method of work sampling is usually a method used in the industry, it has been used for planning and library organization in school libraries by excluding the work sampling technique from the use in the industry.

When the literature is examined for work sampling studies for the service sector, the activities of hospital employees were measured by random sampling; cost, efficiency and leisure time were investigated. Also, a study on the working of the clinical depression specialists and the caregivers working in a psychiatric clinic was conducted and the percentage of the activity distribution of the persons was determined. However, the activities of the nurses were examined in detail using the work sampling method [3]. Güngör and Batmaz have applied the work sampling method to determine the time losses that are not seen in the ERP program, to measure the performances of the employees and to determine the usage situations of the machines, and to determine the periods outside of the personal needs and production [4] . The method of work sampling also has many uses in the field of textiles and apparel. Kiremitçi and Meriç made determinations about the use of production tools (sewing machines and utensils) in the sewing department with the application of work sampling in the operation of two different apparel operations for women upper clothing. [5]. In Güneşoğlu and Meriç's work, he investigated the activities of the operators in the apparel industry and the percentages of distribution of operations, and analyzed their personal spaces and leisure time by means of work sampling method [6]. In Güner et al.'s study, daily activities of employees in the apparel sector were analyzed using work sampling method. Güner examined the effects of different marketing strategies on the workloads and unit costs of round and flat knitting machines by using work sampling technique and compared the causes of low productivity by comparing between two different firms [7].

III. MATERIALS AND METHODS

The aim of this study is to determine the main activities of the male sewing and ironing sections of a man's suits production and to determine the percentages of these activities in the total daily time. The rates reveal the existence, quality and extent of the activities identified and the non-causal periods hidden within the total period. The application of the work was carried out in İzmir province in a firm with an annual production capacity of 265,000 men's suits with 9000 m^2 closed area and 300 employees. The production is band-shaped. Production lines are divided according to the production of jacket (Fig 1) and pants (Fig 2). At the end of the sewing lines there is also an ironing line (Fig 3) where the finished products are ready to be taken and finalized. The study was carried out in all three lines.

Figure 1. Jacket Line

Figure 2. Pants Line

Figure 3. Ironing Line

In this study, work sampling method which is one of measurement techniques is used. work sampling is a simple and cost-effective method that can be used in a variety of situations. It is also less costly and less controversial than time. There is no need for a measuring instrument in the work sample, and as in the time study, it is only a matter of time to look at the work rather than constantly connecting to the work. Experience has shown that the time requirement is less than 40-70% compared to measurements made with the chronometer. Despite all of these advantages, it is disadvantageous that the information about the efficiency level of the worker is not available, it is not possible to scrutinize the short-run flow types and does not allow the working places or the working method to be regulated. The implementation of the work sampling consists of 8 steps. These are shown below (Fig 4): The work steps in these steps are like this[3];

Step 1.Establish The Purpose: First, the objective to be reached by work sampling should be defined. Other processes related to the determination of the purpose are the selection of the business systems and the identification of the human and production means to be observed. The main purpose of the application is to determine the numerical data related to the general situation of the inefficient activities of the workers in the sewing and ironing sections in the production of suits. In this study, inefficient activities are treated as "p" values.

Besides determining the factors that reduce the efficiency and the activities of the employees and getting an idea about whether the workforce is well planned or not. The analysis of the tasks in the jacket, pants and ironing lines were done separately. The activities in each line and the realization rates are determined separately and it is aimed to make proposals to remove the ineffective ones.

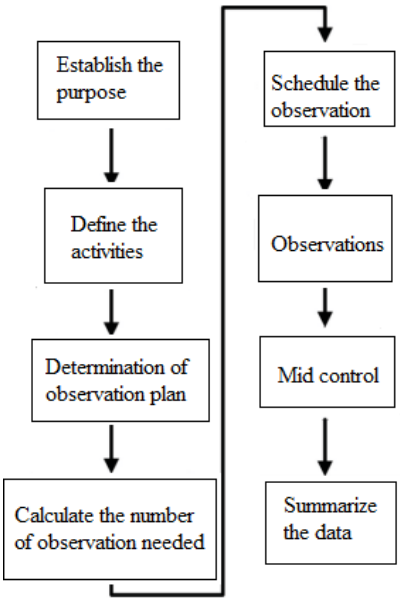

Figure 4. Demonstration of the steps of the work sample [8]

Define The Activities: At this stage, the type of workflow is determined in accordance with the purpose of the study and the observation to be done is made more healthful. The name of the stream types should include a simple and clear description of the work for the observer. In this study, the sewing machine operators working in lines for the jackets and pants and ironing operator working in the ironing line were observed. In these observations, observed activities have been divided into 3 main categories such as productive activity (basic activities), auxiliary activities (additional times) and inefficient activities (non-service times) and each of these activities is defined in detail. The activities for the sewing machine operator in the jacket and pants line in this study were collected in the same table (Table 1), and the activities identified for the ironing operators were listed in Table 2.

Table 1. Activities of Sewing Machine Operators on Jacket and Pant Lines

	ACTIVITY	**DESCRIPTION**
EFFICIENT ACTIVITIES	Sewing	Doing sewing with the sewing machine
	Place the Piece	Placeing the parts machine / automation placement
	Waiting for automation	Waiting for the working time of the machine while sewing on vending machines and checking the work
AUXILIARY ACTIVITIES	Thread Replacement	Chancing threads in the sewing machine
	Replace Bobbin	Replace bobbin thread with new full bobbin when it finished
	Bobbin Filling	Spooling bobbin rewinding thread
	Talking (with master about work)	Talk to the master about the work
	Reading a Job Instruction	Reading a written instruction about the production
	Machine preparation (installation of apparatus, etc.)	Mounting a different apparatus / foot ... etc on the used machine
	Not in Place	Not in place

INEFFICIENT ACTIVITIES	Looking around	Look around outside work
	Talking (to someone else)	Stop work and talk to someone else
	Job Waiting	Job Waiting
	Machine Breakdown	The machine breaks due to a breakdown in the machine
	Reviewing of the Work	Repetitive dictation work
	Handling a Mobile Phone	Busy with mobile phone
	Power Outage	Interruption due to power outage

Table 2. Activities of Ironing Operator on Ironing Line

	ACTIVITY	**DESCRIPTION**
EFFICIENT ACTIVITIES	Ironing	Ironing products with automatic ironing / vending machine
	Place Garment	Place the product to be ironed
	Hang the Garment	Hanging the Garment After Ironed
AUXILIARY ACTIVITIES	Boiler Water Filling	Filling the iron boiler with water
	Adjusting the steam rating	Adjusting the degree of steam / vapor used
	Talking (with master about work)	Talk to the master about the work
	Reading a Job Instruction	Reading a written instruction about the production
	Wait	Ironing automatism standby
INEFFICIENT ACTIVITIES	Not in Place	Not in place
	Looking around	Look around outside work
	Talking (to someone else)	Stop work and talk to someone else
	Job Waiting	Job Waiting
	Machine Breakdown	The machine breaks due to a breakdown in the machine
	Reviewing of the Work	Repetitive dictation work
	Handling a Mobile Phone	Busy with mobile phone
	Power Outage	Interruption due to power outage

Step 3. Determination Of Observation Plan: For the observation to be done, in the third step a circulation plan must be determined on the crook of the survey site. Observations are made in accordance with this circulation plan. For the observations to be made a plan was made to move around the workplace in the order of the personnel to be observed according to the position of the employees. 3 separate roaming plans have been prepared for 3 different lines. In accordance with this circulation plan, records were kept by 3 different observers. Observations were made so as not to distract the machine and the makers, but observations were made at the points where they could be done easily.

Step 4. Calculation of the Number of Observations Needed: At this step, we should ask how many observations we should make in order to reach reliable results. In addition to the level of security to be observed for observations, a margin of error that can be confirmed for observations is also required.

Calculation of the number observation

$$n = \frac{(Z)^2 \text{ x } p \text{ x } (1-p)}{(f')^2} \quad (1)$$

Wherein:
Z = Number of standard deviations associated with a given confidence level (2.58 for 99%, 1.96 for 95%, 1,645 for 90%)
f '= Absolute error that is desired
p = Estimated proportion of time that the activity being measured occurs (%)
n = Number of observations to be made [9]

It is necessary to work with larger samples as the level of confidence desired increases or as the acceptable error rate decreases. In order to be able to calculate the number of observations required, we first need to estimate the share of the flow stream we are looking for (called the "p" share). In our study, the value of "p" is taken as the ratio of inefficient activities in all activities. For this estimation, 100 observations were made at the beginning for each band observed and *n* number of observations was calculated as in Table 3. For this study; Z = 99% confidence and f ' is assumed to be ± 2.5% of absolute error.

Step 5. Scheduling the Observation: At this stage, the start time of each laps is determined. What is important here is to obtain these moments in randomly. Thus, both the statistical conditions are fulfilled and the observer is unlikely to be able to influence the results if they are unconscious.

$$n = N / t \quad (2)$$

n = number of daily observations
N = Number of observations required
t = Application period of the work sample [3].

There are 50 machines in the jacket and pants lines, 28 in the ironing line. The work was planned to be carried out for 5 days, with daily random 30-point views (15 minutes before lunch and 15 minutes after lunch). According to this, the number of daily observations planned to take place in 3 different observation bands are listed in Table 3.

Table 3. (n) Number of Observations

Jacket Line	**Pant Line**	**Ironing Line**
p value = 0,27	p value = 0,23	p value = 0,10
$n = \frac{(2,58)^2 x (0,27) x (0,73)}{(0,025)^2}$	$n = \frac{(2,58)^2 x (0,23) x (0,77)}{(0,025)^2}$	$n = \frac{(2,58)^2 x (0,10) x (0,90)}{(0,025)^2}$
2099 observations	1886 observations	959 observations
Number of observation is 420	Number of observation is 377	Number of observation is 192
Number of operators chosen for observations 14	Number of operators chosen for observations 13	Number of operators chosen for observations 7

Step 6. Observations: Doing the observations as planned.

During the observation, the operating conditions were continuously checked and abnormalities were detected. There were no disruptions to the observations at the workplace. Table 4 contains an example of the forms used during the application. Counting boxes (▧) are used to easily record events observed while observing records are being kept. Each observation is drawn as an edge in box 1, and when the same activity is observed for the 5th time, a box is drawn in the box. Thus, a box passing through the edges and the diagonal from the center was 5 observations

Table 4. Observation Form of Work Sampling

OBSERVATION FORM FOR IRONING OPERATORS																		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
EFFICIENT ACTIVITIES																		
Ironing																		
Place Garment																		
Hang the Garment																		
AUXILIARY ACTIVITIES																		
Boiler Water Filling																		

Adjusting the steam rating																	
Talking (with master about work)																	
Reading a Job Instruction																	
Wait																	
INEFFICIENT ACTIVITIES																	
Not in Place																	
Looking around																	
Talking (to someone else)																	
Job Waiting																	
Machine Breakdown																	
Reviewing of the Work																	
Handling a Mobile Phone																	
Power Outage																	

Step 7. Mid Control: A mid control is made on observations made. Using the new p-value (p) obtained in the intermediate control and the formula (1), a new number of observations (n) is determined.

After half of the 5-day measurement period has been completed (at the end of the 3rd day) an interim check is performed. The number of observations was recalculated according to the new p value obtained when the observed observations were analyzed according to the types of activities.

Table 5. Mid Control of Observations

Jacket Line	**Pants Line**	**Ironing Line**
Numbers of observations after 3 days 1260	Numbers of observations after 3 days 1170	Numbers of observations after 3 days 630
New p value = 0,23	New p value = 0,16	New p value = 0,08
$n = \frac{(2,58)^2 x(0,23) x(0,77)}{(0,025)^2}$	$n = \frac{(2,58)^2 x(0,16) x(0,84)}{(0,025)^2}$	$n = \frac{(2,58)^2 x(0,08) x(0,92)}{(0,025)^2}$
New calculated numbers of observation 1886	New calculated numbers of observation 1432	New calculated numbers of observation 784

Step 8. Final Evaluation: The final evaluation consists of the following phases;

- Calculating the total number of observations and percentages of each activity,
- Calculation of the percentage of each activity in total observation,
- Calculation the error tolerance (f) for each activity,
- It is the decision of the availability of job sampling data.
-

IV. RESULTS

As a result of the mid control performed during the observation of the research, the number of observations decreased. For sewing machine operators in jacket line was 1892 within 5th day, in pants line was 1443 within 4th and ironing operators in ironing line was 800 within4th day. Since the activities of the jacket and pant lines are the same the amounts and ratios in the total observation are shown in Table 6 and the results for the activities of ironing operators are given in Table 7.

Table 6. General Results of Observation from Jacket and Pants Lines

		JACKET LINE (J)		PANTS LINE (P)	
	ACTIVITIES	**TOTAL OBSERVATION NUMBER**	**RATIO IN TOTAL OBSERVATION**	**TOTAL OBSERVATION NUMBER**	**RATIO IN TOTAL OBSERVATION**
EFFICIENT ACTIVITIES	Sewing	1172	61,95%	1113	77,13%
	Place the Piece	248	13,11%	50	3,47%
	Waiting for automation	12	0,63%	28	1,94%
TOTAL OF EFFICIENT ACTIVITIES		**1432**	**75,69**	**1191**	**82,54%**
AUXILIARY ACTIVITIES	Thread Replacement	5	0,26%	19	1,32%
	Replace Bobbin	5	0,26%	1	0,07%
	Bobbin Filling	5	0,26%	10	0,69%
	Talking (with master about work)	20	1,06%	14	0,97%
	Reading a Job Instruction	2	0,11%	1	0,07%
	Machine preparation (installation of apparatus, etc.)	0	0,00%	1	0,07%
TOTAL OF AUXILIARY ACTIVITIES		**37**	**1,95**	**46**	**3,19%**
INEFFICIENT ACTIVITIES	Not in Place	180	9,52%	111	7,69%
	Looking around	85	4,49%	18	1,25%
	Talking (to someone else)	90	4,76%	55	3,81%
	Job Waiting	3	0,16%	14	0,97%
	Machine Breakdown	22	1,16%	0	0,00%
	Reviewing of the Work	43	2,27%	4	0,28%
	Handling a Mobile Phone	0	0,00%	4	0,28%
	Power Outage	0	0,00%	0	0,00%
TOTAL OF INEFFICIENT ACTIVITIES		**423**	**22,36**	**206**	**14,28%**
GENERAL TOTAL		**1892**	**100,00%**	**1443**	**100,00%**

According to the p values found after the observation results obtained, the amount of f 'absolute errors were calculated according to the initially predicted 99% confidence level.
f '(jacket) = ± 2,45%
f '(pants) = ± 2,35%
f '(iron) = ± 2,16%
. The error amounts are within limits.
At the end of the observations, we can see the results that can give us an idea about the inefficient activities which negatively affect the general situation and productivity of the company. Inefficient activities, another name called divisive time, which goes a lot in the literature; are times that occur during different periods of time and at different times during the course of the business and precise measurements are not possible. Some of the divisive times arise due to job duties (additional activities, breaks due to malfunction, etc.). These are called divisive times for work. Some divisive times have nothing to do with business. These are called divisive times due to personal needs, as they are a pause for personal reasons [7]. When the inefficient times observed in the study are examined according to this separation in terms of the sections, the results in Table 8 are emerging.

Table 7. General Results of Observation from Ironing Line (I)

	ACTIVITIES	TOTAL OBSERVATION NUMBER	RATIO IN TOTAL OBSERVATION
EFFICIENT ACTIVITIES	Ironing	348	43,50%
	Place Garment	153	19,13%
	Hang the Garment	135	16,88%
TOTAL OF EFFICIENT ACTIVITIES		**636**	**79,50%**
AUXILIARY ACTIVITIES	Boiler Water Filling	2	0,25%
	Adjusting the steam rating	9	1,13%
	Talking (with master about work)	12	1,50%
	Reading a Job Instruction	2	0,25%
	Wait	93	11,63%
TOTAL OF AUXILIARY ACTIVITIES		**118**	**14,75%**
INEFFICIENT ACTIVITIES	Not in Place	13	1,63%
	Looking around	8	1,00%
	Talking (to someone else)	19	2,38%
	Job Waiting	2	0,25%
	Machine Breakdown	0	0,00%
	Reviewing of the Work	4	0,50%
	Handling Mobile Phone	0	0,00%
	Power Outage	0	0,00%
TOTAL OF INEFFICIENT ACTIVITIES		**46**	**5,75%**
GENERAL TOTAL		**800**	**100,00%**

When the results for the jacket (J) and pants (P) lines are examined, the idle time ratio of the jacket line is higher than the idle time ratio of the pants line. Despite the fact that it is in the same business, the observations of different idle time rates necessitate a review of the activities resulting from work and personal needs It can be seen that almost all of the difference between the sewing lines according to Table 8 is due to divisive time due to personal needs. This difference was due to the ability of the line manager to manage. Despite having the same business, the managers of the two lines were different. The fact that the 5.75% idle time ratio of the ironing line is very low compared to the sewing lines. The reason for this difference was that there was a more dynamic structure of the ironing band then the others.

V. CONCLUSION

Those who perform the same job continuously in one business have a higher rate of efficient activity and fewer other activities. It is anticipated that the efficient activity rate of machines operating in a ready-to-wear garment will be at least 70-75%, while auxiliary activities and inefficient activities are expected to be at maximum 12-14% [7]. In the light of this information, although the minimum activity rate condition was captured in the values recorded in the operation, the difference was observed to be inefficient in the jacket line, even though the assist activity rate was expected to be very small. The most important problem in this regard is the lack of discipline within the band. The first improvement work on the business should be started from here. Thus the idle times will be minimized.

Table 8. Sub-Activities of Ineffective (Idle) Times

		J	P	J-P	I
IDLE TIME FOR PERSONAL NEEDS	**Not in Place**	9,52%	7,69%	1,83%	1,63%
	Looking around	4,49%	1,25%	3,24%	1,00%
	Talking (to someone else)	4,76%	3,81%	0,95%	2,38%
	Reviewing of the Work	2,27%	0,28%	1,99%	0,50%
	Handling Mobile Phone	0,00%	0,28%	-0,28%	0,00%
TOTAL IDLE TIME FOR PERSONAL NEEDS		21,04%	13,31%	7,73%	5,50%
IDLE TIME FOR OTHER REASONS	**Power Outage**	0,00%	0,00%	0,00%	0,00%
	Job Waiting	0,16%	0,97%	-0,81%	0,25%
	Machine Breakdown	1,16%	0,00%	1,16%	0,00%
TOTAL IDLE TIME FOR OTHER REASONS		1,32%	0,97%	0,35%	0,25%
TOTAL TIME OF INEFFICIENT ACTIVITIES		**22,36%**	**14,28%**	**8,08%**	**5,75%**

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