Lecture – 43
Computation of Standard Time - I

Namaskar friends, welcome to the 3rd session of the 9th week of our discussion on our course on work system design, as you are well aware that we are currently focused on understanding the basic concept of work measurement and we are trying to find out the tools and techniques which can help us to set a standard time for doing a particular task, which task, how the task has to be performed, what is the best way of performing that task already we have understood in previous discussion on method study.

So, the outcome of the method study is the one best method which is the most efficient, most effective, most productive method of doing a particular work. Now, once we know that this is the method of doing this particular work now, we need to find out that how much time it will take to perform the work in the specified manner, the specified manner can be a sequence or the use of assistive device.

The specified manner can also involve the basic micro motions or a particular sequence of micro motions, so depending upon the specified method; we now want to find out what is the standard time for required for performing the task following the standard sequence of operations. Also sometimes, the time is an important commodity, we may like to compare 2 or 3 or 4 different methods of doing the same job by finding out that which one is most time efficient.

So, we would like to find out or set the standard time for all methods for all 4 methods for example and then we can see that out of the 4 methods which one is giving us the minimum time at the defined level of performance that is another criteria to be satisfied and the same standard procedure has to be followed. Standard procedure means that what is the right way of doing the work that has to be followed.

So, which means that now we are comparing 4 different methods, out of the 4, as per our belief, the best method must take less time but there are other criteria also which must also be satisfied, so our time standards or the standard time that we follow or that we find out is not only going to help us in one direction but it is going to help us in multiple dimensions, it may be used as a input for the materials requirement planning.

It can help as an input for finding out the cost of our products, it can also help us to decide the salaries, wages, incentives, bonus for our workers, so the time standards are really, really important and by today, we have understood 2 or 3 important terms related to setting the time standards and what are these terms? The first one is the observed time that we do by direct measurement or sometimes we may use data which is already available with us to find out the time for the various work elements.

So, we may look for the available data and try to figure out the time for the defined work elements or the work elements for which the standard, not the standard but the data is already or the time data is already available, so there can be different methods for that. So, 1st thing is the observed time, in many cases we will divide the work into the individual elements and for each element, we will try to do the direct measurement using the stopwatch and tried to find out how much time that element will take to perform.

And it is not a single reading, we may do an average of 10 readings or average of 20 recordings or average of 50 readings that we record using the stopwatch that is the first one, the first term that is clear to you by now is the observed time. In many books, you may find it may be used as selected time also but in our discussion, we are using it as an observed time. The second important parameter that we have understood is the performance rating.

Because, each one of us do the task at a different pace, so it has to be compared with the standard pace at which able bodied who is physically fit, who is mentally alert, who is skilful, who is experienced, so the worker who has all these attributes, how much time he or she will take to perform the task, so we say that we have to establish a standard rate or a standard level of performance.

So, whatever rate at which or pace at which I am working, it may be faster than the standard pace or it can be slower than the standard pace and therefore, we use a concept of performance rating, so 2 important terms are now clear to you, first thing is the observed time, second is the performance rating. Now, how to calculate the performance rating, we have already seen that there are different methods for finding out the performance rating.

Just to revise, Westinghouse method was one method which was used or which can be used for finding out the rating or the performance rating. So, now you know the observed time, you know the performance rating and if you go back or refer back to the last session, we have talked about the various types of allowances that are given to the worker, when we set the standard time. What are these allowances?

We have seen that relaxation allowances, the delay allowances, the policy allowances, so there are different types of allowances which are added to the basic or the normal time to get the standard time, so basically now if you see we have observed time that is number 1, then we have the performance rating, these 2 will give us the basic or the normal time and to this normal time when we add the allowances, we will get the standard time.

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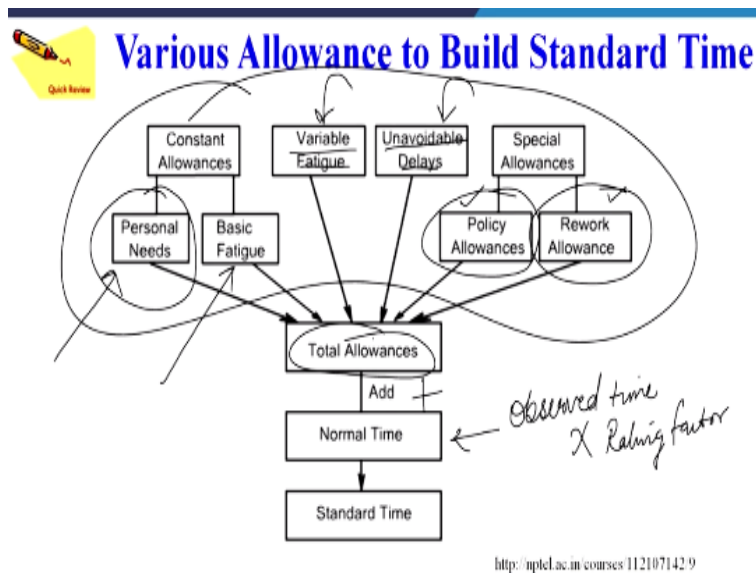
So, just to revise what we have covered in the previous session, we can see that this was the slide which we have already seen, so there are different types of allowances such as we give allowances for personal needs such as drinking water or washing hands, then we give allowance in terms of time to overcome the basic fatigue, so there can be depending upon the type of work being done there can be variable fatigue also which is being caused to the worker.

Then, there are unavoidable delays; these also have to be accounted for in the allowances, then there are special allowances that we have seen in the previous session, policy allowance and the rework allowance. Now, the policy allowance is usually given where the trade union has entered into an agreement or a memorandum of understanding with the management and then in order to ensure minimum wages, so this particular policy allowance is added while calculation of the wages.

So, you have policy allowance, which are special, rework allowance; many times it is understood that out of 100 pieces being produced, 3 pieces are going to be defective, so the time that will be required to rework on these 3 pieces can be added as an allowance or can be considered as an allowance or allowance in terms of time, so we can see that there are different types of allowances, so all these are the allowances which have to be taken into account.

So, these are the; this will give us total allowances which have to be given, when we add these allowances to the normal time, which we have already calculated, so normal time is calculated if you all remember, it is calculated with the help of observed time multiplied by the rating factor. So, we can very easily now get the normal time, so normal time is known to us, allowances also we have already found out that during or for a particular type of work how much allowances must be given.

And when we add the normal time and the allowances, we get our final data or the final time standard which we call as the standard time. At this standard time, calculation is the matter of discussion or is the objective for today's session, after the today's session, all of you must be able to solve simple problems related to calculation of the standard time. So, today we are going to
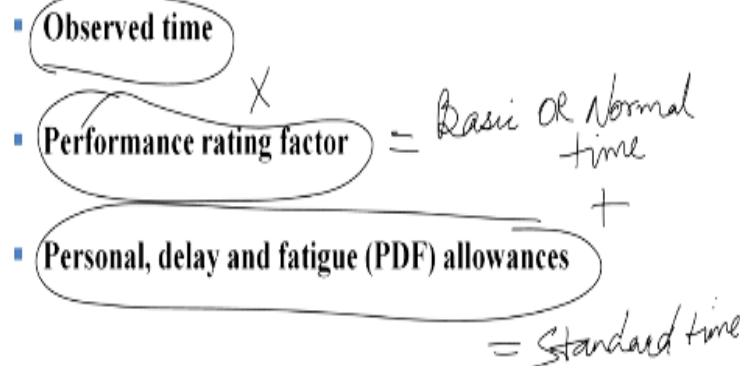
discuss 3 problems very, very simple problems, which will help us or maybe help you to revise one by one that how to calculate the standard time.

So, I think if you have understood it easily, there are 3, 4 terms that are being used again and again; observed time, rating factor, normal time, allowances and finally, the standard time, so all these will be used in mathematical form in the form of it is not going to be a very, very difficult mathematics, it is just going to be a matriculate level of mathematics involved, here we are going to use simple symbols such as or simple actions such as addition, deletion, multiplication, division.

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Method of Calculation

The Standard Time is the product of three factors:

- Observed time

  $\times$

- Performance rating factor $=$ Basi OR Normal time

- Personal, delay and fatigue (PDF) allowances

  $+$

  $=$ Standard time

So, based on that we will be able to calculate the standard time, now let us see may be the method of calculation; the standard time is the product of 3 factors, so what are the 3 factors; the observed time, when it is multiplied by the performance rating factor, we get the basic or other authors make use the normal time also, so this is the normal time and in this, when we add these allowances; personal, delay, fatigue + policy allowance, rework allowance, different types of allowances.

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Computation of Basic Time

- **Basic time**: Time for carrying out an element of work at standard rating.

- **Basic time** = observed time x (**Observed rating** /Standard rating)

- (*It is also called as* ***normal time.***)

$$x \times \frac{120}{100}$$

When they are added to the basic or the normal time, we get the standard time and that is; what is the topic that we are focusing on today, now how do we calculate the basic time. Already, you know first of all let me clarify this point number 3, it is also called the normal time, so maybe in the previous sessions we have used the term normal time, so normal time or basic time it is more or less same.

So, basic time is the time for carrying out an element of work at standard rating or standard level of performance, so how do we calculate the basic time? It is given, all of you know observed time multiplied by the observed rating sometimes, maybe suppose, we give this observed rating as 120, standard rating in taken as 100, so whatever is the observed time suppose, it is x, so my basic time will become x * 120 which is observed rating divided by 100, which is the standard rating.

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Computation of Standard Time

- **Standard time** : Total time in which a job should be completed at standard performance.

  Obs-time × R.F

- Standard time= Basic time + Allowances

So, this will give me the basic or the normal time and to this basic normal time, I will add the allowances to get the standard time. Standard time is a total time in which the job should be completed at standard level of performance, so standard time is the basic time which we already know, which is the multiplication of observed time into the rating factor + the allowances. Now, how the allowances have to be accounted for in the calculation of standard time.

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Method of Calculation

- The standard time can then be calculated by using:

  Standard Time = Observed time x rating factor (1 + PDF allowances)

  Standard Time = Normal time (1 + allowances)

  $$\text{Standard time} = \text{Normal time} \times \frac{100}{100 - \%\,\text{Allowances}}$$

There are different formulae, which are used by different authors in different books, so we will see almost all of them, so the standard time can then be calculated by using, you can see the standard time is the observed time multiplied by the rating factor * 1 + these allowances, PDF; I

think I have skipped this, here is the word PDF coming into picture, so PDF basically is personal delay and fatigue allowances.

And in many cases, we may have the additional allowances also such as the policy and the rework allowance, so here we see 1 + the allowances, so what are these allowances that is personal delay and fatigue allowances. Standard time can also be calculated as the normal time multiplied by 1 + the allowances, so here it may so happen that the allowances are given as a percentage of the normal time that the allowances as 10% of the normal time have to be given for the calculation of standard time.

So, in that case our mathematical relation becomes much simpler, normal time we can calculate by multiplying the observed time with the ratings * 1 + the allowances, so the allowances are a percentage of the normal time. Standard time can also be calculated as normal time * 100 divided by 100 - percentage allowances, so maybe we can use any of these equation depending upon the type of data that is available with u.

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Techniques to Establish a Standard Time

The standard time can be determined using the following techniques:

- Time study
- Predetermined Motion Time System
- Standard Data
- Work Sampling

Now, we will try to see some of the examples related to calculation of the standard time, so here you can see the standard time can be determined using the following techniques, so we can see, we can calculate the standard time using time study, predetermined motion time system, standard

data and work sampling. So, currently we are trying to set the time standard using the most primitive type of direct measurement.

We take the direct readings of the workers performing the various work elements, for each work element we may take number of ratings and then take an average value of these number of readings, then multiplied by the rating factor, then add the allowances that have to be given and thereby we get the standard time but in predetermined motion time system, standard data as well as in work sampling, the approach will slightly be different.

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Example

- In a time study exercise, the **time observed** for an activity was 54 seconds.
- The operator had a **performance rating** of 120.
- A personal time allowance of 10% is given.
- *Determine the standard time for the activity.*

$$\text{Obs. time} = 54 \text{ secs}, \quad \text{Rating} = 120, \quad A = 10\%$$

$$\text{Basic time} = 54 \times \frac{120}{100} = x$$

$$\text{Std time} = x + \text{allowances}$$

And we will learn this in our subsequent sessions, let us take an example on your screen, you can see a very simple example in a time study exercise, the time observed for an activity was 54 seconds, so this is the time observed for an activity that is 54 seconds, now it is maybe direct observation, so this time we can say as the observed time, so the observed time is 54 seconds. The operators have a performance rating of 120, so the standard rating is 100, so we can very easily calculate now if I try to solve this problem here, the solution is on the next slide.

We have the observed time, which is given to us is 54 seconds, rating is given as 120, already given, a personal allowance of 10% is given, so we have seen personal delay as well as the fatigue allowance, so here only personal time allowance of 10% is given, so we can say

allowance is 10%. So, now determine the standard times, so for this activity for which we have found out through direct observation that the time taken is 54 seconds.

What is going to be the standard time? So, let us now see first of all we will try to calculate the basic time, which will be equal to 54 that is the observed time multiplied by the rating which is given divided by the standard ratings, so we will get this value and to this value, suppose this is x, now our standard time will be x + the allowances, so allowances are already given, so we will try to see now what is the solution given.

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This is the standard approach for solving such type of problem, now you can see the normal time is observed time, which is 54 seconds already given to us, multiplied by the performance rating which is given as 120 divided standard ratings, so 54 * 120/100, so this is the normal time whatever value we get here it is used for the calculation of standard time, standard time is normal time * 100 divided by 100 - % allowance.

Now, % allowance, if you see is given 10% here, so we can very easily see standard time is 54 * 120 divided by 100 * 100 divided by 100-10, so 72 seconds is the answer for this simple situation, so maybe you know now simply we need to have observed time, we need to have a rating and if the rating is not available, the problem can be slightly more advanced level that you need to first calculate the rating also depending upon the technique that has been specified.

For example, you are given that calculate the rating using this method, so first you to calculate the rating, once you know the rating then you need to multiplied with the observed time to calculate the normal or the basic time + the allowances, so allowances also can be added into the normal time using different techniques, so here this particular standard approach has been followed in which 100 divided by 100 - % allowances use.

In other cases, it can be easily calculated as I can again write for you, standard time is = normal time * 1 + allowances, so we can incorporate the allowances using this approach also, which is already given if we go back you can see this was already given, normal time * 1 + allowances, this is given here, so this is the answer, 72 seconds.

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Now, let us see the another example; a stopwatch time study on an operator with a performance rating, so again a performance rating is given that is 120 yielded a time of 2 minutes, so observed time is also given, if a loss of 10% here you can see 10% of the total available time are to be given, find the standard time of the operations. So, here slight you can say, variation is there in the way the allowances are specified.

Allowances are specified as 10% of the total available time, so this we have to take into account when we do our calculation otherwise, it is a fairly simple, 2 minutes is given as observed time,

rating is given, standard rating it will give us the basic time and now in this case, the standard time that we need to calculate can be calculated as basic time * 1 + the allowances, so we can calculate the basic time.

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And then, we can since the allowances are also given as the percentage; 10% of the total available time, so we can use this formulation here to calculate the standard time, let us see whether the same has been used, so standard time of the operation is the basic time + allowances standard formula, basic time is observed time which is 2.; in this case 2, sorry let us see again, it is 2 minutes, so the observed time is 2 minutes.

So, observed time is 2 multiplied by rating factor is 120 divided by the standard rating factor which is 100, so 2.4 minutes is the basic time, allowances are 10% of the total available time, so the total available time is 2.4 here basic time * 10% of that, so 2.4 minutes, so the allowances are 10% of the total available time and a total available time, we have already calculated as 2.4 minutes, so 10% of that we have to calculate.

The total available time is 2.4, 10% of that written by 100, oh, this is not correct, it must be 0.24 minute, so now we have already the allowances which are 10% of the total available time and now we can calculate the standard time of the operation, which is the basic time, this is the basic

time + the allowances. Now, what are the allowances? Allowances are 10% of the basic time, so here if you see we are using a completely different method of accounting for the allowances.

In previous case, we have taken as the basic time * 100 divided by 100 - allowances and here we are taking normal time * 1 + allowances or normal time + normal time * the allowances, so depending upon the situation and the way we have been given the data, we will be able to solve the problem and account for the allowances. The basic philosophy is that the worker needs some additional time for his attending to his personal needs; he may require sometimes a tool change.

Sometimes some unavoidable delay maybe, then there is an interference, there are different types of allowances that have to be accounted for, so therefore, again I am coming to the same point that suppose, a worker can produce a job in 1 hour and he is in the shop for 8 hours, so it is not mandatory that he will be able to produce 8 jobs why? Because there are different types of situations, allowances, unavoidable delays, fatigue wear and tear of machine, tool breakage.

So, all these factors have to be accounted for in the form of allowances and when we give the allowances, there can be different mathematical treatments but the overall philosophy remains the same that whatever is the basic work content, we need to reinforce it with certain allowances. Now, here we have seen that the normally, it must have taken 2.4 minutes to perform that activity using a standard level of performance.

But we are giving 0.24 minute as the additional allowances, so the standard time becomes 2.4+0.2 4 as 2.64 minutes which is the standard time for performing an activity which otherwise would have taken 2 minutes only that is the this is given here, this is the direct measurement; 2 minutes but then we have added the allowances and the rating factor to bring it to 2.64 minutes. Now, let us see another problem, this is example number 3 on your screen.

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Example

- An office worker wants to set standard time to complete a task K comprised of **three job elements.** He clocked work elements and chose to take **6 cycles** as shown in table . **The allowance for the task is 12%** and performance rating for each element is also given in the table.

- *Find the normal time and standard time to complete the task.*

Let us try to first understand the problem; an office worker wants to set standard time, so in all the problems we are trying to calculate the standard time which is our objective. An office worker wants to set standard time to complete a task K, so the name of the task is task K, it is comprised of 3 job elements, so the total work or the task is divided into 3 job elements and what is the job element?

Please refer back to the previous discussion in which we have seen that a shirt is being stitched, so different work elements can be there for completing this task of stitching a shirt, so 3 job elements. One of the job elements in case of an example of a stitching of shirt can be fixing up of the buttons or a zipper whatever the need may be. He clocked the work elements and chose to take 6 cycles as shown in table, so 6 cycles of work have been done.

The allowance for the task is if you see allowance for the task is 12%, the total allowance is given and the performance rating for each element is also given, so that will be given in the table, which is given in the next slide, so what we need to do; we need to find the normal time, first question, standard time to complete the task, second question, so 2 things; 1 and 2 and if you have understood the concept both are interrelated.

You cannot directly go to the standard time especially, in case of where we have made the direct observation without calculating the normal time, so in case of time study or in case of direct

observation of the work being done or the various elements being taken into account, we can; we have to calculate first normal time and from normal time we will next go to the standard time. Now, let us try to understand the problem.

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This is the problem as you know, this task K is made up of 3 elements; element 1, element 2 and element 3, so cycles observed; 6 cycles have been observed, this is 1, 2, 3, 4, 5 and 6 and the data is given, job element 1 in first cycle, it took 15 minutes, second element took 30 minutes and the last element took 4 minutes, in the 6th cycle, first element took 40 minutes, second element took 23 minutes, third element took 4 minutes.

So, we can see here for all the 6 cycles for each and every element the times have been recorded, the performance rating is also given, 100% for element 1 and 100% for element 3 and 110% for element number 2, so we have got the performance rating, we have got the time or we can say for each cycle, now, what we need to do here? First, we need to find out the average of this and if you closely observe this data, there is a value of 45 which is seem to be; which seems to be kind of a random value.

Because otherwise, you see for job element 1, 6 readings are available with us for 6 work cycles, so in these 6 readings, if you see, 15, 10, 13, 17 and 14 may be they are nearby only, one rating is 45 which seems to be erroneous, so we can cross this reading. Similarly, for next also, 30, 20, 26,

72 seems slightly erroneous, so we cut this also, 25 and 23 are well within the range. In case of element number 3; 4, 3, 2, 3, 5, 4 all are in the range.

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Solution

- We can see from the data that some of the observations are **unusual** like fifth observation for job element 1 and fourth observation for job element 2.
- These are non-recurring observation which might be result of some disturbance during time study performance. So, **delete these unusual observations** and compute the average time for all three job elements for rest of the observation.

Now, what we need to do? We need to first calculate the average time for each element, so we will see the solution now, whatever I have told, I am again reading for you. We can see from the data that some of the observations are unusual like the 5th observation for job element 1 and 4th observation for job element 2, so this is a 1, 2, 3, 4, 5th observation for job element 1 and 4th observation for job element 2.

So, both these we have to strike out, these are non-recurring observations which might be the result of some disturbance during the time study performance, so delete these unusual observations and compute the average time for all 3 job elements for the rest of the observations.

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Solution

- Average time for job element 1= $(15+10+13+17+14)/5 = $ 13.8 min
- Average time for job element 2= $(30+20+26+25+23)/5 = $ 24.8 min
- Average time for job element 3= $(4+3+2+3+5+4)/6 = $ 3.5 min
- *Calculation of the normal time for each job element considering performance rating:* $100/100$
- Normal time for job element 1= $(13.8)x(1.00) = $ 13.8 minutes
- Normal time for job element 2= $(24.8)x(1.10) = $ 27.28 minutes
- Normal time for job element 3= $(3.5)x(1.00) = $ 3.5 minutes $\frac{110}{100} = 1.1$

So, let us see; now, average time for job element 1, why we have taken 6 readings but we are dividing it by 5, why because 1 reading, 5th reading we have already discarded, so we are adding up all the individual time estimates or time recorded for 6 different or in this case 5 different cycle and dividing it by 5 and trying to find out the average time for job element 1. Similarly, you calculate the average time for job element 2.

And here also, we are dividing it by 5 only because although, we have recorded the time for 6 cycles but we have discarded one-time estimate or one time recording why, because it was giving an erroneous or may be a non-recurring type of value or a random value, so again, divided by 5, we get the average time for job element 2 and similarly, we get the average time for job element 3 and here it is divided by all the 6 value.

Because we are considering all the 6 values, so it is divided by all the 6; it is divided by 6 because we have recorded the time for 6 cycles for all the 3 different elements of the task K. Now, calculation of the normal time for each job element, average values are already given, so the normal time is calculated or the basic time is calculated by multiplying it by the rating factor, so 1 is coming because the rating factor is 100 divided by 100, so it is 1; so 13.8 * 1.

Similarly, 24.8 that is the time; observed time or the average time for job element 2, so here this is multiplied by the rating factor, since it is 1.10, why because the rating; performance rating is

given as 110 divided by 100, so this comes out to be 1.1, so 1.1 is being multiplied by the observed times, then similarly for the third job element also 3.5 which is coming from here multiplied by 1 because the performance rating is 100 divided by 100.

So, this way we calculate the normal times for each of the work elements, there are 3 work elements, so we have found out the normal times for the 3 work elements, now we need to account for the allowances which are given 12%.

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Solution

- Total normal time to complete the task
- $= 13.8 + 27.28 + 3.5 = \boxed{44.58}$ minutes
- The standard time to complete the task considering allowance of 12%.

$$\text{Standard Time} = \text{Normal time} (1 + \text{allowances})$$

- **Standard time** $= 44.58 (1 + 0.12) = \boxed{49.929 \text{ minutes}}$

Allowances

Total normal time

So, total time to complete the task, now we can see normal time, it is 44.58 minutes, so the total normal time is 44.58 minutes, the standard time to complete the task considering allowance of 12%, we know this standard formulation; standard time is = normal time * 1 + the allowances, so standard time is 44.58 which we have calculate as the total normal time multiplied by this is the total normal time; total normal time, which is coming from here.

And we are multiplying it by 1 + 0.; these are the allowances which are already given in the problem, so we calculate the standard time for doing the task, so in this way we can very easily establish a standard time for performing the task and I must have addressed by the end of today's session that it is not something that we are doing only theoretically and we are using some mathematics to do the calculations.

I must also emphasise that in industry also similar practices are used for starting up the standard times and with the standard time as the basis, work is allocated to the workers and workers have to prove their performance based on the work allocated to them based on the standard time, so with this, we conclude the today's session. In the next session, we will see further issues or problems related to the calculation of standard time. Thank you.