

Aggregate planning

Introduction

An organization can finalize its business plans on the recommendation of demand forecast. Once business plans are ready, an organization can do backward working from the final sales unit to raw materials required. Thus annual and quarterly plans are broken down into labor, raw material, working capital, etc. requirements over a medium-range period (6 months to 18 months). This process of working out production requirements for a medium range is called aggregate planning.

Factors Affecting Aggregate Planning

Aggregate planning is an operational activity critical to the organization as it looks to balance long-term strategic planning with short term production success. Following factors are critical before an aggregate planning process can actually start;

- A complete information is required about available production facility and raw materials.
- A solid demand forecast covering the medium-range period
- Financial planning surrounding the production cost which includes raw material, labor, inventory planning, etc.
- Organization policy around labor management, quality management, etc.

For aggregate planning to be a success, following inputs are required;

- An aggregate demand forecast for the relevant period
- Evaluation of all the available means to manage capacity planning like sub-contracting, outsourcing, etc.
- Existing operational status of workforce (number, skill set, etc.), inventory level and production efficiency

Aggregate planning will ensure that organization can plan for workforce level, inventory level and production rate in line with its strategic goal and objective.

Aggregate planning as an Operational Tool

Aggregate planning helps achieve balance between operation goal, financial goal and overall strategic objective of the organization. It serves as a platform to manage capacity and demand planning.

In a scenario where demand is not matching the capacity, an organization can try to balance both by pricing, promotion, order management and new demand creation.

In scenario where capacity is not matching demand, an organization can try to balance the both by various alternatives such as.

- Laying off/hiring excess/inadequate excess/inadequate excess/inadequate workforce until demand decrease/increase.
- Including overtime as part of scheduling there by creating additional capacity.
- Hiring a temporary workforce for a fix period or outsourcing activity to a sub-contractor.

Importance of Aggregate Planning

Aggregate planning plays an important part in achieving long-term objectives of the organization. Aggregate planning helps in:

- Achieving financial goals by reducing overall variable cost and improving the bottom line
- Maximum utilization of the available production facility
- Provide customer delight by matching demand and reducing wait time for customers
- Reduce investment in inventory stocking

- Able to meet scheduling goals there by creating a happy and satisfied work force

Aggregate Planning Strategies

There are three types of aggregate planning strategies available for organization to choose from. They are as follows.

1. Level Strategy

As the name suggests, level strategy looks to maintain a steady production rate and workforce level. In this strategy, organization requires a robust forecast demand as to increase or decrease production in anticipation of lower or higher customer demand. Advantage of level strategy is steady workforce. Disadvantage of level strategy is high inventory and increase back logs.

2. Chase Strategy

As the name suggests, chase strategy looks to dynamically match demand with production. Advantage of chase strategy is lower inventory levels and back logs. Disadvantage is lower productivity, quality and depressed work force.

3. Hybrid Strategy

As the name suggests, hybrid strategy looks to balance between level strategy and chase strategy.

Capacity Planning

The production system design planning considers input requirements, conversion process and output. After considering the forecast and long-term planning organization should undertake capacity planning.

Capacity is defined as the ability to achieve, store or produce. **For an organization, capacity would be the ability of a given system to produce output within the specific time period.** In operations, management capacity is referred as an amount of the input resources available to produce relative output over period of time.

In general, terms capacity is referred as maximum production capacity, which can be attained within a normal working schedule.

Capacity planning is essential to be determining optimum utilization of resource and plays an important role decision-making process, for example, extension of existing operations, modification to product lines, starting new products, etc.

Strategic Capacity Planning

A technique used to identify and measure overall capacity of production is referred to as strategic capacity planning. Strategic capacity planning is utilized for capital intensive resource like plant, machinery, labor, etc.

Strategic capacity planning is essential as it helps the organization in meeting the future requirements of the organization. Planning ensures that operating cost are maintained at a minimum possible level without affecting the quality. It ensures the organization remain competitive and can achieve the long-term growth plan.

Capacity Planning Classification

Capacity planning based on the timeline is classified into three main categories long range, medium range and short range.

Long Term Capacity: Long range capacity of an organization is dependent on various other capacities like design capacity, production capacity, sustainable capacity and effective capacity. Design capacity is the maximum output possible as indicated by equipment manufacturer under ideal working condition.

Production capacity is the maximum output possible from equipment under normal working condition or day.

Sustainable capacity is the maximum production level achievable in realistic work condition and considering normal machine breakdown, maintenance, etc.

Effective capacity is the optimum production level under pre-defined job and work-schedules, normal machine breakdown, maintenance, etc.

Medium Term Capacity: The strategic capacity planning undertaken by organization for 2 to 3 years of a time frame is referred to as medium term capacity planning.

Short Term Capacity: The strategic planning undertaken by organization for a daily weekly or quarterly time frame is referred to as short term capacity planning.

Goal of Capacity Planning

The ultimate goal of capacity planning is to meet the current and future level of the requirement at a minimal wastage. The three types of capacity planning based on goal are lead capacity planning, lag strategy planning and match strategy planning.

Factors Affecting Capacity Planning

Effective capacity planning is dependent upon factors like production facility (layout, design, and location), product line or matrix, production technology, human capital (job design, compensation), operational structure (scheduling, quality assurance) and external structure (policy, safety regulations)

Forecasting v/s Capacity Planning

There would be a scenario where capacity planning done on a basis of forecasting may not exactly match. For example, there could be a scenario where demand is more than production capacity; in this situation, a company needs to fulfill its requirement by buying from outside. If demand is equal to production capacity; company is in a position to use its production capacity to the fullest. If the demand is less than the production capacity, company can choose to reduce the production or share its output with other manufacturers.

Work Study

To survive in the current competitive and global environment, it is important for the organization to continuously look at ways to improve efficiency and productivity. It needs to discover a new, easy and cost-effective way of manufacturing or providing services.

Work study and industrial engineering play important role in job simplification, job design, job enrichment, value analysis/engineering, method analysis, operational analysis, etc. Work study has been utilized by companies to job productivity. Industrial engineering is the latest method employed to improve productivity. It deals with design, enhancement and setting up of engineering systems encompassing plants, machinery, workers, etc.

Work study uses techniques like method study and work measurement to understand human work potential in terms of time spend on completing a task, looking at ways to make the task simpler and easy, as to increase productivity and efficiency. Work study is field used to finding ways of increasing on job performance, optimum usage of plant and machinery, standardization of work methods, etc. Therefore, objectives of work study are as follows:

- Scientific and controlled analysis of existing available methods of executing a task.
- Measuring performance of mentally and the physically qualified workers, establishing it as standard for performance measurement.
- Optimum utilization of workers, plant, machinery and other resources at minimum cost.
- Improved productivity and enhance worker mood.
- Increasing efficiency of organization.

For an organization, productivity can be increased over a period of time, if workers are efficient and are focused. Therefore, advantages of work study are as follows:

- Increase in production efficiency.
- Higher levels of production and optimum utilization of resources.
- Efficient flow of material and products.
- Efficient handling of material and better layout.
- Decreased cost of production as times spend on the job is decreased.
- Increased morale of workers with an increase in safety and efficiency.
- Benchmark and standard performance level are established, thus providing targets for organization.
- Better job satisfaction and incentive planning due to work study.

Method Study

It is a scientific process to better job design. It studies the existing job process and proposed job process as to identify the appropriate job process which results in efficient and cost effective operations. Therefore, objectives of method study are as follows:

- To study existing work process and proposed work process.
- To find out new methods of increased production and reduction of cost.
- To achieve optimum utilization of resources.

Method study ensures that there is an increase in overall productivity and profitability of organization. Method study involves following procedures:

- Selection of work to be studied.
- Recording the present method.
- Critical examination of the facts.
- Development of most practical, economic and effective method.
- Installation of new method.
- Maintenance of new method and practices checking

Production planning and control

For efficient, effective and economical operation in a manufacturing unit of an organization, it is essential to integrate the production planning and control system. Production planning and subsequent production control follow adaption of product design and finalization of a production process.

Production planning and control address a fundamental problem of low productivity, inventory management and resource utilization.

Production planning is required for scheduling, dispatch, inspection, quality management, inventory management, supply management and equipment management. Production control ensures that production team can achieve required production target, optimum utilization of resources, quality management and cost savings.

Planning and control are an essential ingredient for success of an operation unit. The benefits of production planning and control are as follows:

- It ensures that optimum utilization of production capacity is achieved, by proper scheduling of the machine items which reduces the idle time as well as over use.
- It ensures that inventory level are maintained at optimum levels at all time, i.e. there is no over-stocking or under-stocking.
- It also ensures that production time is kept at optimum level and thereby increasing the turnover time.
- Since it overlooks all aspects of production, quality of final product is always maintained.

Production Planning

Production planning is one part of production planning and control dealing with basic concepts of what to produce, when to produce, how much to produce, etc. It involves taking a long-term view at overall production planning. Therefore, objectives of production planning are as follows:

- To ensure right quantity and quality of raw material, equipment, etc. are available during times of production.
- To ensure capacity utilization is in tune with forecast demand at all the time.

A well thought production planning ensures that overall production process is streamlined providing following benefits:

- Organization can deliver a product in a timely and regular manner.
- Supplier are informed will in advance for the requirement of raw materials.
- It reduces investment in inventory.
- It reduces overall production cost by driving in efficiency.

Production planning takes care of two basic strategies' product planning and process planning. Production planning is done at three different time dependent levels i.e. long-range planning dealing with facility planning, capital investment, location planning, etc.; medium-range planning deals with demand forecast and capacity planning and lastly short term planning dealing with day to day operations.

Production Control

Production control looks to utilize different type of control techniques to achieve optimum performance out of the production system as to achieve overall production planning targets. Therefore, objectives of production control are as follows:

- Regulate inventory management
- Organize the production schedules

- Optimum utilization of resources and production process

The advantages of robust production control are as follows:

- Ensure a smooth flow of all production processes
- Ensure production cost savings thereby improving the bottom line
- Control wastage of resources
- It maintains standard of quality through the production life cycle.

Production control cannot be same across all the organization. Production control is dependent upon the following factors:

- Nature of production(job oriented, service oriented, etc.)
- Nature of operation
- Size of operation

Production planning and control are essential for customer delight and overall success of an organization.

Work Measurement

Work measurement is also called by the name 'time study'. Work measurement is absolutely essential for both the planning and control of operations. Without measurement data, we cannot determine the capacity of facilities or it is not possible to quote delivery dates or costs. We are not in a position to determine the rate of production and also labor utilization and efficiency. It may not be possible to introduce incentive schemes and standard costs for budget control.

Objectives of Work Measurement

The use of work measurement as a basis for incentives is only a small part of its total application. The objectives of work measurement are to provide a sound basis for:

1. Comparing alternative methods.
2. Assessing the correct initial manning (manpower requirement planning).
3. Planning and control.
4. Realistic costing.
5. Financial incentive schemes.
6. Delivery date of goods.
7. Cost reduction and cost control.
8. Identifying substandard workers.
9. Training new employees.

Techniques of Work measurement in Production Management

For the purpose of work measurement, work can be regarded as:

1. Repetitive work: The type of work in which the main operation or group of operations repeat continuously during the time spent at the job. These apply to work cycles of

extremely short duration.

2. Non-repetitive work: It includes some type of maintenance and construction work, where the work cycle itself is hardly ever repeated identically.

Various techniques of work measurement are:

1. Time study (stop watch technique),
2. Synthesis,
3. Work sampling,
4. Predetermined motion and time study,
5. Analytical estimating.

Time study and work sampling involve direct observation and the remaining are data based and analytical in nature.

1. Time study: A work measurement technique for recording the times and rates of working for the elements of a specified job carried out under specified conditions and for analyzing the data so as to determine the time necessary for carrying out the job at the defined level of performance. In other words measuring the time through stop watch is called time study.
2. Synthetic data:
A work measurement technique for building up the time for a job or parts of the job at a defined level of performance by totaling element times obtained previously from time studies on other jobs containing the elements concerned or from synthetic data.
3. Work sampling:
A technique in which a large number of observations are made over a period of time of one or group of machines, processes or workers. Each observation records what is happening at that instant and the percentage of observations recorded for a particular activity, or delay, is a measure of the percentage of time during which that activities delay occurs.
4. Predetermined motion time study (PMTS):
A work measurement technique whereby times established for basic human motions (classified according to the nature of the motion and conditions under which it is made) are used to build up the time for a job at the defined level of performance. The most commonly used PMTS is known as Methods Time Measurement (MTM).
5. Analytical estimating:
A work measurement technique, being a development of estimating, whereby the time required to carry out elements of a job at a defined level of performance is estimated partly from knowledge and practical experience of the elements concerned and partly from synthetic data. The work measurement techniques and their applications are shown in the following table.

Work Measurement techniques in Operations Management

Work measurement techniques and their application

<i>Techniques</i>	<i>Applications</i>	<i>Unit of measurement</i>
1. Time study	Short cycle repetitive jobs. Widely used for direct work.	Centiminute (0.01 min)
2. Synthetic Data	Short cycle repetitive jobs.	Centi minutes
3. Working sampling	Long cycle jobs/heterogeneous operations.	Minutes
4. MTM	Manual operations confined to one work centre.	TMU (1 TMU = 0.006 min)
5. Analytical estimation	Short cycle non-repetitive job.	Minutes

TIME STUDY

Time study is also called work measurement. It is essential for both planning and control of operations. According to British Standard Institute time study has been defined as *“The application of techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance.”*

Steps in Making Time Study

Stop watch time is the basic technique for determining accurate time standards. They are economical for repetitive type of work. Steps in taking the time study are:

1. Select the work to be studied.
2. Obtain and record all the information available about the job, the operator and the working conditions likely to affect the time study work.
3. Breakdown the operation into elements. An element is a instinct part of a specified activity composed of one or more fundamental motions selected for convenience of observation and timing.
4. Measure the time by means of a stop watch taken by the operator to perform each element of the operation. Either continuous method or snap back method of timing could be used.
5. At the same time, assess the operators effective speed of work relative to the observer’s concept of ‘normal’ speed. This is called performance rating
6. Adjust the observed time by rating factor to obtain normal time for each element
Normal = Observed time Rating
7. Add the suitable allowances to compensate for fatigue, personal needs, contingencies etc. to give standard time for each element.
8. Compute allowed time for the entire job by adding elemental standard times considering frequency of occurrence of each element.
9. Make a detailed job description describing the method for which the standard time is established.
10. Test and review standards wherever necessary. The basic steps in time study are represented by a block diagram in the figure “Steps in time study”

Computation of Standard Time

Standard time is the time allowed to an operator to carry out the specified task under specified conditions and defined level of performance. The various allowances are added to the normal time as applicable to get the standard time "Components standard time".

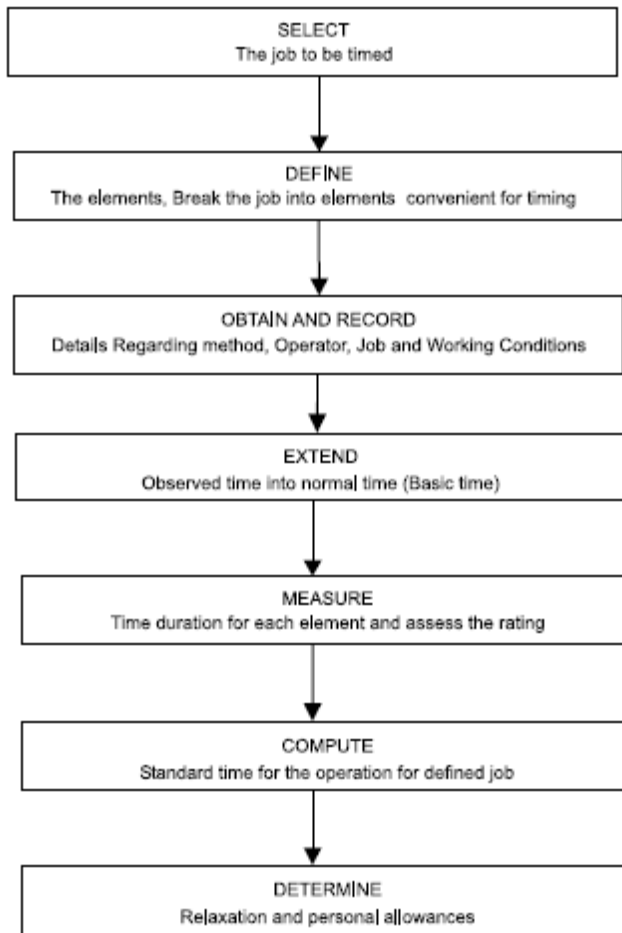
Standard time Calculation time study

Standard time may be defined as the, amount of time required to complete a unit of work: (a) under existing working conditions, (b) using the specified method and machinery, (c) by an operator, able to the work in a proper manner, and (d) at a standard pace.

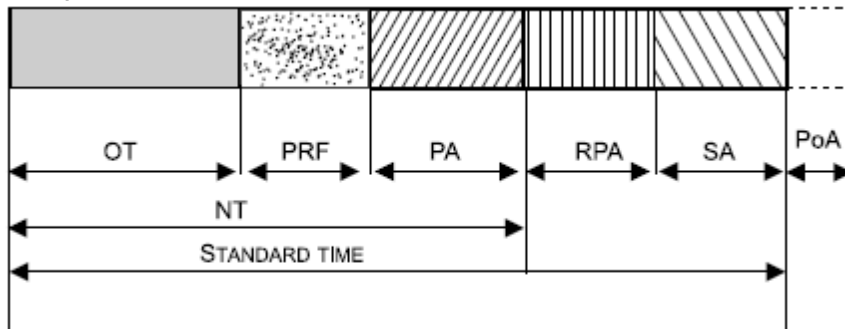
Thus basic constituents of standard time are:

1. Elemental (observed time).
2. Performance rating to compensate for difference in pace of working.
3. Relaxation allowance.
4. Interference and contingency allowance.
5. Policy allowance.

Steps in time study



Components standard time



- OT – Observed Time
- PRF – Performance Rating Factor
- NT – Normal Time
- PA – Process Allowances
- RPA – Rest and Personal Allowances
- SA – Special Allowances
- PoA – Policy Allowances

Allowances

The normal time for an operation does not contain any allowances for the worker. It is impossible to work throughout the day even though the most practicable, effective method has been developed.

Even under the best working method situation, the job will still demand the expenditure of human effort and some allowance must therefore be made for recovery from fatigue and for relaxation. Allowances must also be made to enable the worker to attend to his personal needs. The allowances are categorized as:

1. Relaxation allowance,
2. Interference allowance, and
3. Contingency allowance.

RELAXATION ALLOWANCE

Relaxation allowances are calculated so as to allow the worker to recover from fatigue. Relaxation allowance is a addition to the basic time intended to provide the worker with the opportunity to recover from the physiological and psychological effects of carrying out specified work under specified conditions and to allow attention to personal needs. The amount of allowance will depend on nature of the job.

Relaxation allowances are of two types: fixed allowances and variable allowances.

Fixed allowances constitute:

- a. Personal needs allowance:
It is intended to compensate the operator for the time necessary to leave, the workplace to attend to personal needs like drinking water, smoking, washing hands. Women require longer personal allowance than men. A fair personal allowance is 5% for men, and 7% for women.
- b. Allowances for basic fatigue:
This allowance is given to compensate for energy expended during working. A common figure considered as allowance is 4% of the basic time.

VARIABLE ALLOWANCE

Variable allowance is allowed to an operator who is working under poor environmental conditions that cannot be improved, added stress and strain in performing the job. The variable fatigue allowance is added to the fixed allowance to an operator who is engaged on medium and heavy work and working under abnormal conditions. The amount of variable fatigue allowance varies from organization to organization.

INTERFERENCE ALLOWANCE

It is an allowance of time included into the work content of the job to compensate the

operator for the unavoidable loss of production due to simultaneous stoppage of two or more machines being operated by him. This allowance is applicable for machine or process controlled jobs. Interference allowance varies in proportion to number of machines assigned to the operator. The interference of the machine increases the work content.

CONTINGENCY ALLOWANCE

A contingency allowance is a small allowance of time which may be included in a standard time to meet legitimate and expected items of work or delays. The precise measurement of which is uneconomical because of their infrequent or irregular occurrence.

This allowance provides for small unavoidable delays as well as for occasional minor extra work: Some of the examples calling for contingency allowance are:

- Tool breakage involving removal of tool from the holder and all other activities to insert new tool into the tool holder.
- Power failures of small duration.
- Obtaining the necessary tools and gauges from central tool store. Contingency allowance should not exceed 5%.

POLICY ALLOWANCE

Policy allowances are not the genuine part of the time study and should be used with utmost care and only in clearly defined circumstances. The usual reason for making the policy allowance is to line up standard times with requirements of wage agreement between employers and trade unions.

The policy allowance is an increment, other than bonus increment, applied to a standard time (or to some constituent part of it, e.g., work content) to provide a satisfactory level of earnings for a specified level of performance under exceptional circumstances. Policy allowances are sometimes made as imperfect functioning of a division or part of a plant.

ILLUSTRATION 1: Assuming that the total observed time for an operation of assembling an electric switch is 1.00 min. If the rating is 120%, find normal time. If an allowance of 10% is allowed for the operation, determine the standard time.

SOLUTION:

Observed time (or) selected time = 1.00 min
Rating = 120%
Allowance = 10%

$$\begin{aligned}\text{As we know that, normal time} &= \text{Observed time} \times \frac{\text{Rating \%}}{100} \\ &= 1.00 \times \frac{120}{100} = \mathbf{1.20 \text{ min}}\end{aligned}$$

$$\text{Allowance @ 10\%} = 1.20 \times \frac{10}{100} = \mathbf{0.12 \text{ min}}$$

$$\begin{aligned}\therefore \text{Standard time} &= \text{Normal time} + \text{Allowances} \\ &= 1.20 + 0.12 = \mathbf{1.32 \text{ min.}}\end{aligned}$$

ILLUSTRATION 2: *An operator manufactures 50 jobs in 6 hours and 30 minutes. If this time includes the time for setting his machine. Calculate the operator's efficiency. Standard time allowed for the job was:*

$$\text{Setting time} = 35 \text{ min}$$

$$\text{Production time per piece} = 8 \text{ min}$$

SOLUTION:

As standard time = Set up time + Time per piece \times No. of pieces produced

\therefore Standard time for manufacturing 50 jobs

$$= 35 + 8 \times 50$$

$$= 435 \text{ min}$$

$$= 7 \text{ hours and } 15 \text{ min.}$$

$$\begin{aligned}\text{Efficiency of operator} &= \frac{\text{Standard time} \times 100}{\text{Actual time}} \\ &= \frac{435 \times 100}{390} = \mathbf{111.5\%}.\end{aligned}$$

ILLUSTRATION 3: Following data were obtained by a work study. Man from a study conducted by hours.

(i) Maintenance time

- (a) Get out and put away tools = 12.0 min/day
- (b) Cleaning of machine = 5.0 min/day
- (c) Oiling of machine = 5.0 min/day
- (d) Replenish coolant supply = 3.0 min/day

(ii) Interruption

- (a) Interruption by foreman = 5.0 min/day
- (b) Interruption by porter etc. = 4.0 min/day
- (iii) Delay time due to power failure etc. = 6.0 min/day
- (iv) Personal time = 20.0 min/day

Calculate total allowances, total available cycle time productive hours, considering a working day of 8 hours.

SOLUTION:

Total allowance (sometimes also known as station time)

$$\begin{aligned}
 &= \text{Total maintenance time} + \text{Interruption time} \\
 &\quad + \text{Delay time} + \text{Personal time} \\
 &= (12.0 + 5 + 5 + 3.0) + (5.0 + 4.0) + 6.0 + 20.0 \\
 &= 25.0 + 9.0 + 6.0 + 20.0 \\
 &= 60.0 \text{ min per day}
 \end{aligned}$$

$$\begin{aligned}
 \therefore \text{Total available cycle time} &= \text{Total work period} - \text{Total allowances} \\
 &= 480 - 60 = 420 \text{ min/day}
 \end{aligned}$$

$$\begin{aligned}
 \text{Productive hours} &= \frac{\text{Time available}}{\text{Number of hours}} \\
 &= \frac{420}{8} = 52.5 \text{ min.}
 \end{aligned}$$

ILLUSTRATION 4: Find out the standard time using the following data:

- Average time for machine elements = 6 min
- Average time for manual elements = 4 min
- Performance rating = 110%
- Allowances = 10%

SOLUTION:

$$\begin{aligned}
 \text{Normal time} &= \text{Machinery time} + \text{Manual time} \times \text{Rating} \\
 &= 6 + 4 \times 1.1 \\
 &= 6 + 4.4 = 10.4 \text{ min}
 \end{aligned}$$

\therefore Standard time = Normal time + Allowances

$$\begin{aligned}
 &= 10.4 + 10.4 \times \frac{10}{100} \\
 &= 10.4 (1 + 0.1) = 11.44 \text{ min.}
 \end{aligned}$$