

1ST EDITION

OPERATIONS

MANAGEMEMENT

NUR AIN BINTI MAHAT SITI MARIAM BINTI SAMAT Operations Management DPB50133 First publish 2023 ©Nur Ain Binti Mahat and Siti Mariam Binti Samat Publish by Politeknik Tuanku Sultanah Bahiyah

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PREFACE

Welcome to the Operations Management (DPB50133) course.

This course is a requirement for students studying Diploma in Business Studies. This course provides a foundation and useful insight to the application of methods and techniques for those who are interested to major Operations Management. Even if you are not planning on career in the operations area, you will be likely be working with people in operations. This course would be useful since the knowledge or concepts of Operations Management has practical application to your future job and everyday life. This module is designed specifically for students of Politeknik Malaysia. The scope and content follow the syllabus closely. It is a self-instructional material to aid students to study independently with minimum reliance on the lecturer's guidance. Our aim in writing this book is to give students a comprehensive understanding of Operations Management course. Students can improve their calculation techniques with the examples containing worked solutions that are incorporated throughout the book. To test understanding, students can apply their knowledge of each chapter using the end of chapter exercises. Hopefully, the materials presented in this module will be useful, interesting and even exciting. Good Luck !

> NUR AIN MAHAT SITI MARIAM SAMAT

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CHAPTER 1 INTRODUCTION TO OPERATIONS MANAGEMENT AND PRODUCTIVITY





Definition of Operation Management

- Defined as activities related to the creation of goods or services by converting or transforming inputs into outputs.
- Operations system is a system where the main function is to create goods and services. A system is a set of interacting or independent components or subsystems, designed to achieve common objectives.

Importance Of Operations Management

One of the major functions in an organization

Marketing, Finance, and Operation Management.

)

Enables us to know how goods and services are produced.

8 6-8 Allows us to understand what operations manager do. The person who is responsible in the operations department.

Objectives of Operations Management



Relationship Between Operations and Other Function in an Organization



The functions are closely interrelated-they rely on each other to perform their own activities. The operations function is responsible for producing goods and services. So, it needs financial assistance from the finance function to continue operating, while simultaneously relying on sales forecasts made by the marketing function in planning the output.

The same goes for the finance function, which relies on the operations function to produce goods and services, so that these products can be sold to generate money.

□ Since these functions are interrelated, any change/ problem caused by either of these functions will definitely affect the others. Apart from these three main functions, other functions that are equally important in an organization are human resources management and suppliers.

Characteristic Of Services And Manufactured Product

Services	Manufactured Product
Intangible outputs	Tangible products
Outputs cannot be stored	Products can be stored
High interaction with customer	Low interaction with customer
Difficult in measuring quality	Easy in measuring quality
Labour intensive	Capital intensive

Definition of productivity

• Management productivity is defined as the overall efficiency and output of a given operational system.

• Productivity refers to the rate of output per unit of labor, capital or equipment (input).



Importants Of Productivity

Reduction in labour cost per unit of output.

Reduction in overheads and power cost per unit of output.

Reduction in the price of goods.

Increase in wages and salary.

Increase in the reserve fund that can be utilized for expension and modernization.

Productivity Measurement

Productivity measurement is the best way to assess the ability of a country to improve the living standards of its people. The same goes to an organization where its productivity determines the efficient of the organization.

Productivity = <u>Output produced</u>

Inputs used

Calculate The Productivity Measurement



Single Factor = Output Produced Input Used

Multi Factor = Output Produced

Labour+material+energy+miscellaneous



Example 1

A factory that employs 100 people producing 2000 tables per day. The productivity of each employee is:

Single Factor

- Productivity = <u>Output produced</u> Input used
 - = <u>2000</u> (tables) 100 (workers)
 - = 20 tables per worker per day

Example 2

XYZ incorporated wants to assess its productivity in a broader view. The company has 8 employees, working 8 hours per day (salary is rm10 an hour, which costs the company rm640 of payroll per day). Other expenses incurred per day amounts to rm600. One employee is able to produce 20 units of products in a day.

Multi Factor Productivity = output / input

- $= \frac{8 \times 20}{1000}$
 - Rm640 + Rm600
 - <u>160</u> Rm 1240
- = 0.129 units per RM

CHAPTER 2 PLANT LOCATION STRATEGIES

Plant Location

Definition

Choice of region and selection of a particular site for setting up a business or factory.





Marketing strategy

The Need Of Location Decision



Cost of doing business



Growth



Depletion of resources



Location evaluation technique that considers quantitative and qualitative factors in choosing a location

Factor Rating Technique



Tangible Factors

Cost factors which **can be measured in monetary value**. Example: labour, transportation cost and raw material cost.

Intangible Factors Factors that are hard to be measured in monetary value such: Labour availability, proximity to market and facilities availability

The ratings and their value are given:

Excellent/outstanding = 5 Very good= 4 Good = 3 Fair/satisfactory = 2 Poor = 1

Example 1

Mawar Sari Berhad, a company producing cosmetics has plants at Jitra and Alor Setar. The company intends its operation by opening up a new plant. It has identified four locations: Baling, Kodiang, Sungai Petani and Kulim. The following annual costs and non economic data were gathered as belows.

Tangible Factors (RM'000)	Baling	Kodiang	Sungai Petani	Kulim
Labour	350	360	375	380
Raw Materials	400	375	395	368
Rental	10.0	10.5	11.5	11.0

Example 1

Intangible Factor	Baling	Kodiang	Sungai Petani	Kulim
Labour availability	Very good	fair	good	good
Community acceptance	outstandi ng	poor	fair	Very good
Quality of life	poor	outstanding	good	poor
Transportatio n quality	good	good	Very good	outstanding

Among the intangible factors to be considered, labour availability is the most important factors followed by transportation quality and quality of life. The least important is community acceptance.

Solutions:

1. Find the total cost for all locations.

	Baling	Kodiang	Sungai Petani	Kulim
Total Cost ('000)	760.0	745.5	781.5	759.0

2. Rank the location and assign merits. The lowest total cost is to be given the highest ranking and merit.

	Baling	Kodiang	Sungai Petani	Kulim
Rank	3	1	4	2
Merit	2	4	1	3

3. Choose the best locations based on the highest ranking and merit

	Baling	Kodiang	Sungai Petani	Kulim
Rank	3	1	4	2
Merit	2	4	1	3

Kodiang is the best location because it has the lowest total cost.

Exercise

Location	Labour availability (RM'000)	Raw Material (RM'000)	Overhead Expenses (RM'000)
Kulim	450	310	90
Bayan Lepas	520	350	120
Perai	500	330	100
Sungai Bakap	430	280	80

A Johor based soy sauce company is considering expanding its operation to the northern region of Malaysia. It has identified four potential locations to build a new plant; Kulim, Bayan Lepas, Perai and Sungai Bakap. All essential data for tangible factors are listed as follows:

Which location would you recommended if the evaluation were based only on cost factors?

The rating score for each of the intangible factors is as follows:

Excellent = 5; Very Good = 4; Good = 3; Satisfactory = 2; Poor = 1

Which location would you recommend if the evaluation were based only on this factor?

Tangible Factors

Solution:

1. Find the total cost for all locations.

	Kulim	Bayan Lepas	Prai	Sungai Bakap
Total Cost (000)	850.0	990.0	930.0	790.0

2. Rank the location and assign merits. The **lowest** total cost is to be given the highest ranking and merit.

	Kulim	Bayan Lepas	Prai	Sungai Bakap
Rank	2	4	3	1
Merit	3	1	2	4

3. Choose the best locations based on the highest ranking and merit

	Kulim	Bayan Lepas	Prai	Sungai Bakap
Rank	2	4	3	1
Merit	3	1	2	4

Based on the tangible factors, **Sungai Bakap** is the best location because it has the lowest total cost.

Intangible Factors

	Weight	Kulim	Bayan Lepas	Perai	Sungai Bakap
Labour availability	3	3 = 9	5 = 15	4 = 12	2 = 6
Transportation service	4	4 = 16	4 = 16	5 = 20	3 = 12
Facilities	2	2 = 4	3 = 6	4 = 8	1 = 2
Local incentives	1	5 = 5	3 = 3	2 = 2	4 = 4
Total score		34	40	42	24
Rank		3	2	1	4
Merit		2	3	4	1

Based on the intangible factors, **Perai** is the best location because it has highest total score.

INTEGRATIVE METHOD

Tangible & Intangible Factors	Weight	Kulim	Bayan Lepas	Prai	Sungai Bakap
Tangible	2	2=4	4=8	3=6	1=2
Intangible	1	3=3	2=2	1=1	4=4
Total Score		7	10	7	6
Rank		2	1	2	4

Based on the tangible factors, **Bayan** Lepas is the best location because it has the highest total score.

CHAPTER 3 FACILITIES LAYOUT AND PROCESS STRATEGY



Define Facility Layout Planning

The process by which the placement of departments, workgroups within departments, workstations and machines within a facility is determined.



Objective Of Layout Planning

To provide optimum space to organize equipment and facilitate movement of goods and to create safe and comfortable work environment.





To facilitate extension or change in the layout to accommodate new product line or technology upgration.

To increase production capacity of the organization.

To promote safety of plant as well as its workers.

The Need Of Layout Decision

Changes in environmental or other legal requirements		Changes in methods and equipment		Changes in volume of output or mix of products
Ma	orale problems		Inefficient operations ex: high cost bottlenecks	
Changes in the design of products or services		Safety hazard		The introduction of new product or services
The Important Of Layout Decision

Higher utilization of space.

Reduced bottlenecks in moving people.

Improved employees' morale and safer working conditions.

Efficient use of labor.

Improved customer and vendor interaction.

Basic Layout Pattern



- A product layout refer to a production system, where the workstations and equipment are located along the line of production as with assembly lines.
- Product layouts are found in flow shops (repetitive assembly and process or continuous flow industries).
- Flow shops produce high-volume, highly standardized products that require highly standardized, repetitive processed.
- In a product layout, resources are arranged sequentially, based on the routing of the products.

Product Layout

Example Of Product Layout





Example 2

Product Layout

Advantages	Disadvantages		
 Output. Product layouts can generate a large volume of products in a short time. 	• Motivation. The system's inherent division of labour can result in dull, repetitive jobs that can prove to be quite stressful.		
• Cost. Unit cost is low as a result of the high volume. Labour specialization results in reduced training time and cost.	• Flexibility. Product layouts are inflexible and cannot easily respond to required system changes—especially changes in product or process design.		
• Utilization. There is a high degree of labour and equipment utilization.	• System protection. The system is at risk from equipment breakdown, absenteeism, and downtime due to preventive maintenance.		

Process Oriented Layout

- A Process layout is a design for the floor plan of a plant that involves arranging equipment and facilities according to their function, with the aim of improving efficiency.
- Process layouts are found primarily in job shops, or firms that produce customized, low-volume products that may require different processing requirements and sequences of operations.
- Process layouts are facility configurations in which operations of a similar nature or function are grouped together.
- As such, they occasionally are referred to as functional layouts. Their purpose is to process goods or provide services that involve a variety of processing requirements.

Example Of Process Oriented Layout



Process Oriented Layout

Advantages	Disadvantages
Flexibility. The firm has the ability to handle a variety of processing requirements.	Utilization. Equipment utilization rates in process layout are frequently very low, because machine usage is dependent upon a variety of output requirements.
Cost. Sometimes, the general-purpose equipment utilized may be less costly to purchase and less costly and easier to maintain than specialized equipment.	Cost. If batch processing is used, in- process inventory costs could be high. Lower volume means higher per-unit costs.

Process Oriented Layout

Advantages	Disadvantages		
Motivation. Employees in this type of layout will probably be able to perform a variety of tasks on multiple machines, as opposed to the boredom of performing a repetitive task on an assembly line.	The span of supervision is small due to job complexities (routing, setups, etc.), so supervisory costs are higher.		
System protection. Since there are multiple machines available, process layouts are not particularly vulnerable to equipment failures.	Confusion. Constantly changing schedules and routings make juggling process requirements more difficult.		

Fixed-position Layout

- A fixed-position layout are typical of projects, where the product produced is too fragile, bulky or heavy to move.
- For example, battleships are not produced on an assembly line.
- The product remains in one location and the required tasks and equipment are brought to it. The item being worked on remains stationary workers materials and equipment are moved as needed. People ,materials and machines all come to the fixed-position site for assembly and processing the product.
- <u>Why must used Fixed Position Layout :</u>
- It is used to create a product or service that is either large or one of a kind.
- The product cannot be moved from function or along an assembly line

Example Of Fixed-position Layout



Example 2



Fixed-position Layout

Advantages	Disadvantages		
• Easy for products which are difficult to move.	 Production period being very long, capital investment is very heavy. 		
 Flexibility for change in design, operation sequence, labour availability, exists in this layout. 	 Very large space is required for storage the material and equipment near the product. 		

Fixed-position Layout

Advantages	Disadvantages		
• This layout is very cost effective when many orders of similar type are existing in different stages of progress.	• As several operations are often carried out simultaneously, the possibility of confusion and conflict among different workgroups.		
• Large project type of jobs such as construction are suited in this layout.	• It requires careful project planning and focussed attention on critical activities otherwise confusion, delay and conflict may arise.		

Process Strategies

- Process strategies is defined as an approach used by an organization to transform the input into output.
- Also referred to as a transformation or conversion process that transforms or convert the resources, such as physical and material, financial, human and information to get the best products or outputs.



Process Focus Strategy

- Process Focus is production facilities such as equipment, work centres, materials and workers are organized around specific activities or processes.
- Also called intermittent process or job shop





Repetitive Focus Strategy

- Repetitive Focus is a strategy where production facilities are organized as assembly lines.
- The function of assembly line is to modules, which are parts and components that have been made previously.
- Also called assembly line or production lines.



Product Focus Strategy

- Product Focus Strategies is a process that organizes the facilities by product.
- This strategy is appropriate for organizations that have large quantities of production, as it enable a smooth production process.
- Also known as line flow production and continuous production.

High volume, but low product variety

Less skilled labour

Five Characteristics of PRODUCT FOCUS STRATEGY

More specialized equipment

High fixed cost, but low variable costs Long, continuous production runs, which enable process efficiency

MASS CUSTOMIZATION STRATEGY

- Mass Customization is a manufacturing technique that combines the flexibility and personalization of 'custom-made' with mass production.
- Mass customization is a strategy that combines both process and product focus strategy.
- Almost all type of durable consumer products, can be customized by the buyer at the time of purchase, where customers can specify what they want from the product.



Comparison Of The Process Strategies

	Process Focus	Repetitive	Product Focus	Mass
		Focus		customization
Facility	According to	Assembly lines	By product	A combination
arrangeme	process or			of process and
nt	specific activities			product focus
Output variety	High	Low	Low	High
Efficiency	Low	Moderate to high	High	High
Costs	High variable costs	Low variable costs	High fixed costs	Low unit costs
Skills of Iabour	Highly skilled	Less skilled	Less skilled	Highly skilled
Type of products	Customized	Semi- customized	Standardized	Customized



What Is Forecasting?

Forecasting is a technique that uses historical data as inputs to make informed estimates that are <u>predictive</u> in determining the direction of future trends. Businesses utilize forecasting to determine how to allocate their <u>budgets</u> or plan for anticipated <u>expenses</u> for an upcoming period of time. This is typically based on the projected <u>demand</u> for the goods and services offered.



The Strategic Importance Of Forecasting

 Strategic forecasting makes the company's operations sensitive to market factors on a continuous basis.

 Companies can decide whether to assign additional resources for corrective action, or to change their strategies to reflect the new situation.



Forecasting Methods

Qualitative Forecasting Models

 Qualitative Are Usefull In Developing Forecast With A Limited Scope. These Models Are Highly Reliant On Expert Opinions And Are Most Beneficial In The Short Term. Examples Of Qualitative Forecasting Models Include Market Research, Polls, And Surveys That Apply The Delphi Method.

Quantitative Forecasting Models

 Quantitative Exclude Expert Opinions And Utilize Statistical Data Based On Quantitative Information. Quantitative Forecasting Models Include Time Series Methods, Discounting, Analysis Of Leading Or Lagging Indicators, And Econometric Modeling.



Jury of Executive Opinion

A method of forecasting using a composite forecast prepared by a number of individual experts. The experts form their own opinions initially from the data given and revise their opinions according to the others' opinions. Finally, the individuals' final opinions are combined.

Delphi method

- The Delphi method is a process used to arrive at a group opinion or decision by surveying a panel of experts.
- Experts respond to several rounds of questionnaires, and the responses are aggregated and shared with the group after each round.





Delphi Method

Types of participants:

- **Decision makers** consist of a group 5 to 10 expert who will be making the actual forecast.
- **Staff personnel** assist decision makers by preparing, distributing, collecting and summarizing a series of questionnaire and survey result.
- **Respondent** A group of people often located in different place, whose judgement are valued. This group provide input to the decision makers before the forecast is made.

Discuss Sales Force Composite

A method of forecasting future demand for a product by adding together what each member of the sales force expects to be able to sell in his or her territory.



Forecasting method that solicits input from customers or potential customers regarding future purchasing plans.



Under this method, a forecaster contact almost all the potential users of the product and ask them about their future purchase plan. The probable demand for a product can be obtained by adding all the quantities indicated by the consumers.

Sample Survey:

The sample survey method is often used when the target population under study is large. Only the sample of potential consumers is selected for the interview. A sample of consumers is selected through a sampling method

End-use Method:

3

The end-use method is mainly used to forecast the demand for inputs. This method of demand forecasting has a considerable theoretical and practical value

Consumer Market Survey

Is forecasting method which is used to gather information related to the market that cannot be collected from the company's internal records or the external published sources of data.

Objectives Of Market Survey

To understand the impact of sales activities : Sales activities are the backbone of an organization and it becomes crucial to keep track of these activities. Market surveys for sales activities will produce a report of the impact of sales activities, whether their frequency needs to increase or any changes the audiences think should be inculcated in the sales process.

To measure customer loyalty : What is the degree of loyalty that the customers have towards and organization? The answer to this question can be obtained by conducting a market survey.



2

To establish buyer personal : These surveys are to build a buyer persona by knowing about customer preferences, inclination, and capabilities of purchasing a product.





Naïve Approach

A forecasting technique that assumes that demand in the next period is EQUAL to demand in the most recent period.
Naive Approach Explanation

In This Approach Firms Use Previous Data From Actual Period To Forecast The Future Upcoming Period By Making No Adjustments. This Approach Is Used Only For The Time Series Data In Which The Firm Can Assume The Future Financial Period Is Equal To The Past One.

Naive Approach formula

 $F_{1}^{\dagger} = A_{1}^{\dagger} - 1$

Ft = Forecast for period

At = Actual Demand For period t

Example: Naïve Approach

MONTH	ORDERS PER MONTH	FORECAST
Jan	120	-
Feb	90	120
Mar	100	90
Apr	75	100
May	110	75
June	50	110
July	75	50
Aug	130	75
Sept	110	130
Oct	90 🔪	110
Nov	-	→ 90

The moving average is calculated by adding a stock's prices over a certain period and dividing the sum by the total number of periods.



Simple Moving Average

The simplest form of a moving average, known as a simple moving average (SMA), is calculated by taking the arithmetic mean of a given set of values over a specified period of time. In other words, a set of numbers–or prices in the case of financial instruments–are added together and then divided by the number of prices in the set. The formula for calculating the simple moving average of a security is as follows:

$$SMA = \frac{A_1 + A_2 + \ldots + A_n}{n}$$

where:

A = Average in period nn = Number of time periods

Demand Forecasting

Example 1 - Simple Moving Average Illustration

Market Mixer, Inc. sells can openers. Monthly sales for an eight-month period were as follows:

Month	Sales	Month	Sales
1	450	5	460
2	425	6	455
3	445	7	430
4	435	8	420

Forecast next month's sales using a 3-month moving average.



Weighted Moving Average

 $Ft = (Wt X At) + (Wt x At) + (Wt x At) + \dots (wn x An)$

Total Weight

Weighted Moving Averages

Week	Sales	2WMA	Weights: 3 and 2
1	39		
2	44		
3	40	42.0	
4	45	41.6	
5	38	43.0	
6	43	40.8	2(42) + 2(20)
7	39	41.0	$F_7 = \frac{3(43) + 2(38)}{r}$
8			5

Compute Exponential Smoothing



The simplest of the exponentially smoothing methods is naturally called simple exponential smoothing (SES). This method is suitable for forecasting data with no clear trend or seasonal pattern.

1. Simple Exponential Smoothing

The basic formula is:

 $S_t = \alpha y_{t-1} + (1 - \alpha) S_{t-1}$ Where:

- α = the smoothing constant, a value from 0 to 1. When α is close to zero, smoothing happens more slowly.
 Following this, the best value for α is the one that results in the smallest mean squared error (MSE). Various ways exist to do this, but a popular method is the Levenberg-Marquardt algorithm.
- t = time period.

Many alternative formulas exist. For example, Roberts (1959) replaced y_{t-1} with the current observation, y_t. Another formula uses the forecast for the previous period and current period:

Ft = Ft - 1 + a(At - 1 - Ft - 1)= a*At - 1 + (1 - a)*Ft - 1

Where:

- Ft 1 = forecast for the previous period,
- At 1 = Actual demand for the period,
- a = weight (between 0 and 1). The closer to zero, the smaller the weight.

Which formula to use is usually a moot point, as most exponential smoothing is performed using software. Whichever formula you use though, you'll have to set an initial observation. This is a judgment call. You could use an average of the first few observations, or you could set the second smoothed value equal to the original observation value to get the ball rolling.

Nilai Alpha $0 \le \alpha \le 1$

Forecasting Methods

- Exponential Smoothing Example
- Assume $\alpha = 0.4$

2	Week	Demand	
87	1	125	- Need initial forecast; Assume 125
	2	175	(0.4)(125) + (0.6)(125) = 125
	3	150	(0.4)(175) + (0.6)(125) = 145
	4	150	(0.4)(150) + (0.6)(145) = 147
	5	160	(0.4)(150) + (0.6)(147) = 148.2
-			(0.4)(160) + (0.6)(148.2) = 152.9

Given	the	fol	lowing	data:
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EXERCISE 1

Period	Number of Complaints	
1	60	
2	65	
3	55	
4	58	
5	64	

Prepare a forecast using each of these approaches:

- a. The appropriate naïve approach.
- b. A three-period moving average.
- c. A weighted average using weights of .50 (most recent), .30, and .20.
- d. Exponential smoothing with a smoothing constant of .40.





Calculate Trend Projection

Definition:

The trend projection method is the most classical method of business forecasting, which is concerned with the movement of variables through time.



Fitting Trend Equation or Least Square Method

- The least square method is a formal technique in which the trend-line is fitted in the time-series using the statistical data to determine the trend of demand.
- The form of trend equation that can be fitted to the time-series data can be determined either by plotting the sales data or trying different forms of the equation that best fits the data. Once the data is plotted, it shows several trends. The most common types of trend equations are least squares method.

Calculate Trend Projection using Least Squares Method



Linear Trend Equation Example

Forecasting

3-6

t Week	ť	y Sales	ty
1	1	150	150
2	4	157	314
3	9	162	486
4	16	166	664
5	25	177	885
$\Sigma t = 15$ (Σt) ² = 225	Σ t ² = 55	Σ y = 812	Σ ty = 2499

Linear Trend Calculation

$$b = \frac{5(2499) - 15(812)}{5(55) - 225} = \frac{12495 - 12180}{275 - 225} = 6.3$$

 $a = \frac{812 - 6.3(15)}{5} = 143.5$

y = 143.5 + 6.3t



Overview Of Aggregate Planning

- Demand for products or services may fluctuated from time to time.
- An operation manager needs to establish a proper production plan to ensure that there is a sufficient amount of supplies to meet fluctuations in demand, yet minimizing the costs of production at the same time.
- Example; The operation manager can use inventory to smoothen out the fluctuations.

Concept Of Aggregate Planning

- Aggregate planning deals with determining the quantity and timing of production for the immediate future.
- The objective of aggregate planning is to meet forecast demand and minimize costs over the planning period.

Effective aggregate planning entails; A logical overall unit for measuring sales and outputs.

- A method for determining costs.
- A model that combines forecasts and costs to enable scheduling decisions to be made for the planning period.



AGGREGATE PLANNING STRATEGIES

- There are altogether eight aggregate planning strategies that the operations manager can opt for.
- The strategies can be grouped into two options which is capacity options and demand options.



Aggregate Planning Strategies

- There are altogether eight aggregate planning strategies that the operations manager can opt for.
- The strategies can be grouped into two options which is capacity options and demand options.

Capacity Options

- Capacity options are chosen when the operations manager is not trying to change demand but will absorb the fluctuations in demand.
- Capacity option have five strategies which is;

1. Changing inventory levels

- 2. Varying workforce size by hiring or laying off workers
- 3. Varying production rates through overtime or idle time
- 4. Varying production rates through subcontracting.
- 5. Using part-time workers during periods with high demand

1. Changing inventory levels

- The size of the workforce and the production rates remain constant throughout the planning period.
- Worker ay be hired to meet the expected demand at he beginning of the planning period.
- This strategy will increase cost relating to inventory.
- Shortages may result in loss of sales caused by long lead times or poor customer service.

2. Varying workforce size by hiring or laying off workers

- The organization will produce exactly based on demand.
- Hires and lay-offs of production workers will be used to match the production rate with demand.
- The organization will incur hiring and lay-offs costs.
- New employees need to be trained, thus incurring training costs.

3. Varying production rates through overtime or idle time

- Allow the organization to maintain a constant size of workforce.
- During high demand periods, production workers will do overtime to meet the increase in demand.
- Overtime can be costly and drive down productivity.
- During low demand periods, production rates will reduce through idle time.

4.Varying production rates through subcontracting

- The company maintains the number of workers and production rates.
- Any shortage will be covered through subcontracting.
- Subcontracting has several disadvantages, namely it can be costly, quality is difficult to ensure and timely delivery of the products is a challenge.

5. Using part-time workers during periods with high demand

- Used to fill unskilled or low-skilled positions, especially in the service sector.
- The practice is widely used in hotels, restaurants and supermarkets.

DEMAND OPTIONS

Demand options are preferred when a firm attempts to influence demand.

Demand options have three strategies which is ;

- Influencing demand
- Backordering during high demand periods
- Counter seasonal products and service mixing

1. Influencing demand

- When demand is low, a company will stimulate demand through aggressive marketing activities.
- The company can use advertising, sales promotions and price cuts to increase demand.
- When demand is high, the company may increase prices to reduce demand
- It may not always be able to balance demand with production capacity

2. Backordering during high demand periods

- Refer to orders that company has accepted, but cannot fulfil at the moment.
- It requires the customers to wait for the delivery of the orders made.
- It is an effective strategy when there are only a few, if any, substitutes for the product or service ordered.

3. Counter seasonal products and service

- Where a company develops a product mix of counter seasonal items.
- This strategy may lead the company to produce products or service beyond its target market

Mixing Options

- The best way to achieve minimum cost.
- With this strategy, production rates are constant, so any excess in production will build inventory.
- Mixing options have two plan which is :

01. Chase Strategy

•Tries to match output rates with forecast demand for a particular period.

Can be accomplished in many ways

• The operations manager can either vary the workforce level through hiring and layoffs or vary outputs through using overtime, idle time, subcontracting or part-time workers.

Mixing options

02. Level Scheduling Strategy

• Where the production rate is constant from time to time.

- The number of workers will remain constant during the planning period.
- Companies using this strategy believe that a stable workforce level will lead to better product quality, less turnovers and absenteeism, as well as employees who are more committed.

• A mixed strategy is used to achive minimum costs.



Chapter 5 Work measurement



Define work measurement

• Definition:

• Work measurement involves determining the time that a qualifies worker should take to complete a job under normal working conditions. Labor standard/ standard time is the time that a job is expected to take.

• Objective :

 Establish a labor standard that is the time taken by a qualified worker to perform a particular task such as to produce one unit of output with allowance made for breaks, personal time and fatigue under normal working conditions.



Normal working conditions

Working conditions relates to physical factors such as temperature, humidity, ventilation ,color, and noise that can have a significant impact on worker performance in term of productivity, quality of output and accidents.



Time Study Method



- Time study is used to determine the time required by a qualified well-trained person working at a normal pace to performs a specified task .
- Time study results in a time standard
- There are three concept of time :
 - i. Observed time
 - ii. Normal time or basic time
 - iii. Standard time


Observed Time

- The time which an operator being observed usually using a stopwatch as the job is being performed .
- Does not take into account contingencies, such as machine breakdowns or the operator's ability and are simply time taken by the particular operator being observed to complete the task.
- The total job is divided into smaller elements and time to complete each element will be taken.
- The number of cycle time should be determined.

Average Observed Time :

Summation of Observed Time

Number of Observation

Basic (Normal) Time

- Time which qualified worker would take to complete the job at normal pace under normal working conditions.
- It takes into account the appropriate level of skill to complete a task.
- Therefore, the normal time is the time taken by qualified worker during the study working at his/her pace.

Basic (Normal) Time : Average Observed Time × Observed Rate

Standard Rate

Standard TIME

 This is the time in which a qualified worker would take to complete a task taking into consideration some allowances

> Standard Time : Basic (Normal) Time (1+ Allowance Factor)

Allowance Time

- The normal time did not take into consideration the allowance such as personal, rest and delay allowance.
- Allowance is included in the calculation of standard time because we cannot expect workers to work nonstop without any break.
- By giving allowance to employees to attend to personal needs, tea or lunch , employees can overcome fatigue .
- Allowance help worker to improve performance or at least continue to perform according to standard.
- There are four (4) types of allowances that are relaxation, contingency, process and policy.

Allowance Factor :

Summation Of Allowances (in minutes second) × 100%

Working Hours Per Day (in minutes second)

Daily Standard Output :

Working Hours Per Day (in minutes or second)

Standard Time

Time Study Method

1. Average Observed Time : Summation of Observed Time

Number of Observation

2. Basic (Normal) Time : *Average Observed Time × Observed Rate*

Standard Rate

3. Standard Time : *Basic (Normal) Time (1+ Allowance Factor)*

4. Allowance Factor :

Summation Of Allowances (in minutes second) × 100%

Working Hours Per Day (in minutes second)

5. Daily Standard Output: <u>Working Hours Per Day (in minutes or second)</u> <u>Standard Time</u>

EXAMPLE 1:

The following data represent the time study observation for the metal working process:

TASK	OBSERVATION TIME			ЛE	PERFOMANCE RATING (%)	Allowance have been set a (in an 8 hours workday Personal time = 30 min/day Relaxation = 50 min/day Process = 20 min/day			
А	2.0	2.5	2.3	2.6	120	i. Calculate the normal time of the			
В	3.5	10.0	3.7	3.0	80	operation ii Compute the allowenes factor			
С	5.0	6.0	8.0	7.0	90	iii. Find the standard time for job			

Solutions (i) : AOT (Average Observed Time)				
Task A	Task B	Task C		
$\frac{2.0+2.5+2.3+2.6}{4}$ =2.35 minutes	$\frac{3.5 + 3.7 + 3.0}{3}$ = 3.4 minutes	$\frac{5.0 + 6.0 + 8.0 + 7.0}{4}$ = 6.5 minutes		
Normal Time = AOT x Observe rate/100				
NT= 2.35 × 120 ÷ 100 = 2.82 min	NT = 3.4 × 80 ÷ 100 = 2.72min	NT= 6.5 × 90 ÷ 100 = 5.85 min		

TOTAL NT = 2.82 + 2.72 + 5.85 = 11.39 min #

Solution (ii):-	Solution (iii) :-
Allowance factor	Standard time
= Sum of allowance working hour per day	= Basic /normal time(1+allow factor)
$= \frac{30+50+2}{8 \times 60} \times 100\%$	=11.39(1+0.21)
= 20.83 @ 21%	= 13.78 min

EXAMPLE 2

The following data represents the time study observation for the metal working process.

JOB ELEMENT	OBSERVATION TIME(MINUTES)					PERFOMANCE DATE
	1	2	3	4	5	
A	45	53	47	51	49	120
В	23	20	46	24	21	110
С	8	8	10	10	9	90

In this company it is a common practice to allow workers a15 minutes coffee break and 30 minutes of personal time per day.(In additional it is estimate that there should be an extra allowance of 27 minutes per day) the working time is from 9am to 5pm.

- I. Compute the allowance factor
- II. Calculate the normal time for the process
- III. Calculate the standard time to complete one units of the product
- IV. Calculate daily output per worker
- V. How many worker are needed to produce 500 units per week? (Assuming a 5 days workweek)











Define Inventor

 Inventory is defined as good on hand or any stock of economic resources at a given point of time , in anticipation of satisfying a future demand for them.

The objective of inventory management is to strike a balance between inventory investment customer service.





To provide a selection of goods for anticipated demand and separate the firm from fluctuations in demand



To separate (decouple) various parts of the production process

Functions of inventory



To take advantage of discounts



To hedge against future price increase

Types of Inventory



Finished goods

Completed product awaiting for shipment an item ready to be sold, but still and asset on the company's books.



Raw Materials

Materials that are usually purchased but have yet to enter the manufacturing process.

Types of inventory

MROs



Work-in-process

Inventories devoted to maintenance/repair/operating supplies necessary to keep machinery and processes productive. (WIP) Products or components that are no longer raw materials but have yet to become finished goods (not completed).

1. ABC Analysis

□ A method for dividing on-hand inventory into three classifications based on annual dollar volume.

□ Inventory is divided into class A, class B, and class C:

Class A items are those which the annual dollar volume is high. Although these items may represent only about 15% of the total inventory items, they represent 70% 80% of the total dollar usage. Class B items is those inventory items of medium annual dollar volume, these items usually represent 15% - 25% of the total inventory value and about 30% of inventory items. Class C items consist of items with low annual dollar volume. These represent about 55% of the inventory items. However, in terms of annual dollar value they only represent 5%.

Policies that are based on the ABC analysis may include the following :

- Supplier development strategy should focus on suppliers of items A compared to items C .
- > Tighter control should be places on items A compared to item B and C.
- > Forecasting for items A requires more care than forecasting for item B and C.

2. Record Accuracy

□ Prerequisite to inventory management.

□Accuracy can be maintained by either periodic or perpetual systems.

- □Periodic systems require regular (periodic) checks of inventory to determine quantity on hand.
- □Perpetual inventory tracks both receipts and subtraction inventory on a continuing basis. Receipts are usually noted in in receiving department in some semi-automated way such as bar-code reader. Subtraction through disbursements are noted as items leave the stock room at the point of sale (POS) cash register.

3. Cycle Counting

□With cycle counting, items are counted and records are updated on a periodic basic.

□To eliminates shutdowns and interruptions of productions, as a result of the annual physical inventories checking.

□It eliminates annual inventory adjustment.

□It uses trained personnel to audit inventory accuracy.

□It allows causes of errors to be identified and corrected.

□It maintains accurate inventory records.

4. Control of service inventories

- □Management of service inventories also deserves special consideration. This is because inventory can be critical component of profitability. Can be used to control service inventories include:
- Good personnel selection, training and discipline: where employees have access to directly consumable merchandise (food-service, wholesale and retail operations).
- Tight control on incoming shipments: use of Universal Product Code (bar code) and radio frequency ID (RFID) systems that read every incoming shipment and automatically check tallies against purchase orders.
- Effective control on all goods leaving the facility: this job is accomplished with bar codes, RFID tags or via direct observations.

Economic Order Quantity (EOQ) model

The economic order quantity EOQ model is an inventory – control technique that minimizes the total or ordering and holding cost.

Assumptions to use EOQ:

- 1. Demand is known, constant and independent of decision for other items.
- 2. Lead time- the time between placement and receipt of the order is known and consistent .
- 3. Receipt of inventory is instantaneous and complete. Orders are delivered as whole units at a single point in time.
- 4. Quantity discounts are not possible.
- 5. The only variable costs are setup costs and holding costs.
- 6. Shortages can be completely avoided if orders are placed at the right time.

Determining the EOQ :

- D = demand per year
- S = ordering cost (RM per order)
- IC = carrying or holding cost per unit per year
- d = demand per day
- L = lead time in days
- ss = safety stock

Total Ordering Cost = (Number of orders placed per year) x (setup or Ordering cost per order)

 $= S\left(\frac{D}{Q}\right)$

Total carrying Cost = (Carrying cost per unit per year) x (Average inventory level)

Number of Orders place per year (N) = $\frac{D}{Q}$

Total Annual Inventory Cost (TAIC) = Setup or ordering cost + Carrying cost

$$= S \left\{ \frac{D}{Q} \right\} + IC\left\{ \frac{Q}{2} \right\}$$

EOQ or Q =
$$\frac{\sqrt{2DS}}{IC}$$

Suppose a firm expects the total demand for its product to be 50,000 units. The ordering cost is RM500 per order and the carrying cost per unit is RM75.

a) Find the EOQ

b) Determine the number of orders placed per year.

Solutions:

D=50,000, S=RM500, IC=RM75 a) EOQ, $Q = \frac{\sqrt{2DS}}{IC}$ EOQ= $\frac{\sqrt{2(50,000)(500)}}{75}$ = 816.50 \approx 817 units

b) Number of orders placed per year = $\frac{D}{Q}$

$$=\frac{30,000}{817} = 61.19 = 61$$
 or 62 orders

EXAMPLE

Maju Jaya Enterprise uses 100 units of component x per day. The ordering cost is RM50 per order and the carrying cost is RM0.05 per unit per day. The lead time is 5 days. The company operates 300 days in a year. In order to protect itself against uncertainty in demand, the company holds a safety stock 3 days usage.

- a) Find EOQ
- b) Determine the reorder point (ROP)
- c) Calculate the ordering cost
- d) Calculate the carrying cost
- e) Calculate the Total Annual Inventory Cost (TAIC)
- f) Determine the number of orders placed per year
- g) Determine the reorder recycle
- h) Determine the minimum inventory level
- i) Determine the maximum inventory level

Summary of information:

- Annual Demand (D)= daily usage (d)x Number of working days in a year = 100x 300 days=30000 units #
- Total ordering Cost(s)= RM50
- Total Carrying Cost (I/C)= RM0.05x 365 days (assuming that there are 365 days in a year)=RM18.25#
- Lead Time (L)= 5 days
- Number of Working Days in a Year = 300 days
- Safety stock (ss) = 3 days x 200 units = 300 units





e) Total Annual Inventory Cost $S[\frac{D}{Q}] + IC[\frac{Q}{2} + SS]$ $= 10[\frac{300000}{405}] + 18.25[\frac{405}{2} + 300]$

= RM740.74+ RM 9170.63 = RM9911.37 f) Number of orders placed per year

 $\frac{D}{Q}$

 $\frac{30000}{405} = 74.07 \approx 74 \ times$



h) Minimum inventory level

300 units (the safety stock)

i) Maximum inventory level

EOQ + safety stock

= 405 + 300 = 705 units

Calculate the Quantity Discount

 Assumes that there are no quantity discounts and no shortages of goods. The quantity discount model assumes that supplier or distributors often offer quantity discounts to their customers to attract the customers to purchase in large quantity.

Two approaches :

- Carrying Cost is Constant
- Carrying Cost is Not Constant

Carrying Cost is Constant

There are five step involved in determining the best order size that will minimize the total annual inventory cost as follow :

Steps:

- Computing the EOQ.
- Finding the unit price that matches EOQ.
- Computing the Total Annual Inventory using the price determined in Step 2.
- Repeating Step 3 for all lower price breaks.
- Selecting the order size that has the lowest Total Annual Inventory Cost.

EXAMPLE :

A company uses 15,000 unit of ballpoint pens per annum. The ordering cost is rm20 per order and the annual carrying cost is RM0.10 per uni. The supplier ha decided to offer a new price structure to attract a larger order from the company. The new price structure is as shown.

Determine the order quantity that will minimize the annual inventory cost

Quantity purchased (units)	Price per unit (RM)
1 - 1999	1.00
2000 - 2999	0.90
3000 - 3999	0.80
4000 and above	0.70

STEP 1 : Compute the EOQ



STEP 2 : Find the unit price that matches the EOQ

• At the EOQ, the unit price is RM0.90

STEP 3:Computing the Total Annual Inventory using the price determined in step Step 2

- (RM0.90x15,000)+RM20[15,000/2,450]+RM0.10[2,450/2]
- RM13,500 + RM122.45 + RM122.50 = RM13,744.95

STEP 4:Repeating Step 3 for all lower price breaks.

- Find the TAIC at RM0.80. The minimum quantity 3,000 units RM0.80x15,000 + RM20[15,000/3,000]+ RM0.10[3,000/2] RM12,000 + RM100+ RM150= RM12,250
- TAIC at RM0.70. The minimum quantity 4,000 units RM0.70x15,000 + RM20[15,000/4,000]+RM0.10[4,000/2] RM10,500 + **RM75+RM200=RM10,775**

STEP 5 : Selecting the order size that has the lowest Total Annual Inventory Cost

• The **best order size is 4000** units because the TAIC is the lowest.



When the carrying cost is not constant and is a percentage of the unit price, there are four step involved in determining the best order size that will minimize the total annual inventory cost, as follow:

Carrying Cost is Not Constant

Step :

 Computing the EOQ for each discount price, starting with the lowest price break until a feasible EOQ is found (an EOQ that fall in the quantity range for its price).
 Calculating the Total Annual Inventory Cost for the feasible EOQ.

3.Then, calculating the Total Annual Inventory Cost for the next lowest price. Here, use the minimum quantity to quantity for the discount as the order quantity. Repeat this Step 3 till the lowest price available in the price structure.

4.Selecting the quantity that given the lowest Total Annual Inventory Cost.

Example :Maju Jaya Manufacturing uses 40,000 units of component X per annum. The ordering cost is RM20 per order and the annual carrying cost is 10% of the units price. The price per unit is RM10. The supplier has recently offered a new price structure to the company. The new structure is as shown:

Quantity purchased (units)	Price per unit (RM)
1 - 1999	10.00
2000 - 2999	9.00
3000 - 3999	8.80
4000 and above	8.75

Step 1 : Computing the EOQ for each discount price

• EOQ =
$$\frac{\sqrt{2DS}}{lC}$$

• $\frac{\sqrt{2(40000)(20)}}{0.875}$ = 1352.25 @1352 units
1352 is not a feasible quantity for the price RM8.70. so, compute EOQ for
the next lowest price I,e RM8.80
• $\frac{\sqrt{2(40000)(20)}}{0.88}$ = 1348.40 @1348units
1348 is not feasible quantity for the price RM8.80. so,compute EOQ for the
next lowest price, i,e RM9
• $\frac{\sqrt{2(40000)(20)}}{0.90}$ = 1333.33 @ 1333 units
1333 is not feasible quantity for the price RM9, so compute EOQ for the next
lowest Price , I.e Rm10
• $\frac{\sqrt{2(40000)(20)}}{0.90}$ = 1264.0 @ 1264 units

•
$$\frac{\sqrt{2(40000)(20)}}{1.00}$$
 = 1264.9 @ 1264 units

1264 is feasible quantity for the price Rm10, because it falls in the RM10 range of 1 to 1999

STEP 2: Calculating the Total Annual Inventory Cost for the feasible EOQ

TAIC (1265) = CD + S $\{D/Q\}$ +IC $\{Q/2\}$

- = $(RM10 \times 40000) + RM20 \{40000/1265\} + RM1 \{1265/2\}$
- = RM4000000 + RM 632.41 + RM 632.50 = RM401264.91

STEP 3 : Calculating the Total Annual Inventory Cost for the next lowest price

- TAIC(2000) = CD + S {D/Q} + IC{Q/2} =(RM9 X 40000) + RM20 {40000/2000} + RM0.90{2000/2} =RM360000 + RM400 + RM900 = RM361300
- TAIC (3,000) (RM8.80x40,000)+RM20[40,000/3,000]+RM0.88[3,000/2]=RM353,586.67
- TAIC (4,000) (RM8.75x40,000)+RM20[40,000/4,000]+RM0.875[4,000/2]=RM351,95
Definition of Just In Time Concept (JIT)





JIT is an inventory strategy companies employ to increase efficiency and decrease waste by receiving goods only as they are needed in the production process, thereby reducing inventory costs.

JIT is an approach of continuous and forced problem solving via a focus on throughput and reduced inventory.

Objectives of JIT





(ii) Zero breakdowns



(iii) 100% on time delivery service



(iv) Elimination of non-value added activities



(v) Zero defects.

Advantages

- ✓There should be minimal amounts of inventory obsolescence, since the high rate of inventory turnover keeps any items from remaining in stock and becoming obsolete.
- ✓ Since production runs are very short, it is easier to halt production of one product type and switch to a different product to meet changes in customer demand.
- ✓The very low inventory levels mean that inventory holding costs (such as warehouse space) are minimized.

Disadvantages

- ✓A supplier that does not deliver goods to the company exactly on time and in the correct amounts could seriously impact the production process.
- ✓ A company may not be able to immediately meet the requirements of a massive and unexpected order, since it has few or no stocks of finished goods.
- ✓A natural disaster could interfere with the flow of goods to the company from suppliers, which could halt production almost at once
- ✓An investment should be made in information technology to link the computer systems of the company and its suppliers, so that they can coordinate the delivery of parts and materials.

CHAPTER 7 PROJECT MANAGEMENT & MAINTENANCE



Definition Of Project Management

• Planning scheduling and controlling of resources such as equipment, workplace and materials, so that the stages meet, costs and technical constraints of the project.

Objective of project management are:

- To ensure that the project will be completed on time
- To manage the project costs so that they are minimized and kept within the expected budget
- To meet the predetermined quality standard.

Three (3) Stages Of Project Management





Includes goal setting, defining the project and team organization.



PROJECT SCHEDULING

Relates people, money, and supplies to specific activities and relates activities to each other.



PROJECT CONTROLLING

Here the firms monitors resources, cost, quality, and budgets. It also revises or changes plans and shifts resources to meet time and cost.

Framework of PERT

PERT follows six (6) basic steps :



Example 1 : Expected Time (t)

• a= Optimistic time

Time an activity will take if everything goes as planned

• b= Pessimistic time

Time an activity will take assuming very unfavorable conditions

• m= Most likely time

Most realistic estimate of the time required to complete an activity

Activity	а	m	b	Immediate predecessors	$t=\frac{a+4m+b}{6}$	Expected time (weeks)
А	1	2	3	-	$=rac{1+4(2)+3}{6}$	2
В	2	3	4	-	$=rac{2+4(3)+4}{6}$	3
С	4	5	6	А	$=rac{4+4(5)+6}{6}$	5
D	8	9	10	В	$=rac{8+4(9)+10}{6}$	9
E	2	5	8	C,D	$=rac{2+4(5)+8}{6}$	5
F	4	5	6	D	$=rac{4+4(5)+6}{6}$	5
G	1	2	3	E	$=rac{1+4(2)+3}{6}$	2



Critical path

Start - B - D - E - G - End

Completion Time (LONGEST PATH)

= 3 + 9 + 5 + 2 = 19 weeks.

ΑCTIVITY TIME							
Activity	ES	EF	LS	LF	Slack (LS –ES)	On critical path	
А	0	2	5	7	5 - 0 = 5	NO	
В	0	3	0	3	0 - 0 = 0	YES	
С	2	7	7	12	7 – 2 = 5	NO	
D	3	12	3	12	3 – 3 = 0	YES	
E	12	17	12	17	12 – 12 =0	YES	
F	12	17	14	19	14 – 12 =2	NO	
G	17	19	17	19	17 – 17 =0	YES	

EXAMPLE 2

The activities described by the following table are given for the J. C Howard Corporation in Kansas:

ACTIVITY	IMMEDIATE PREDECESSOR (S)	TIME
A	-	9
В	А	7
С	А	3
D	В	6
E	В	9
F	С	4
G	E,F	6
Н	D	5
I	G,H	3

Draw the appropriate AON PERT diagram for J.C. Howard's management team.



Find the critical path.

Critical Path = A - B - E - G - I

Activity	ES	EF	LS	LF	Slack LS-LF	On Critical Path	Time
А	0	9	0	9	0	Yes	9
В	9	16	9	16	0	Yes	7
С	9	12	18	21	9	No	3
D	16	22	20	26	4	No	6
E	16	25	16	25	0	Yes	9
F	12	16	21	25	9	No	4
G	25	31	25	31	0	Yes	6
Н	22	27	26	31	4	No	5
I	31	34	31	34	0	Yes	3

What is the project completion time?

Project completion time = 9 + 7 + 9 + 6 + 3

= 34 weeks

Example 3:

The expected times and immediate predecessors for the activities in a project at Howard Umrah's retinal scanning company are given in the following table. Assume that the activity times are independent.

Activity	Immediate predecessor	Time(week) 10 10 10			
A					
B	· ///				
С	A				
D	В	8			

Solutions: Construct The Pert Network



Critical Path

			ACTIVII				
	Activity	ES	EF	LS	LF	Slack (LS –ES)	On critical path
-	А	0	10	0	10	0 - 0 = 0	YES
	В	0	10	2	12	2 – 0 = 2	NO
	С	10	20	10	20	10 - 10 =0	YES
	D	10	18	12	20	12 – 10 =2	NO

Critical path = A– C Completion time = 10 + 10 = 20 weeks.

Let's do exercise

Stephen Hall is developing a program in supply chain management certification for managers. Hall has listed a number of activities that must be completed before a training program of this nature could be conducted. The activities , immediate predecessors, and time appear in the accompanying table.

- 1. Construct the PERT network.
- 2. What is the expected completion time of the critical path ?

ΑCTIVITY	IMMEDIATE PREDECESSOR(s)	TIME
A	-	2
В	_	5
С	_	1
D	В	10
E	A,D	3
F	С	6
G	E,F	8

Define Maintenance In Operations

Maintenance is defined as all activities involved in ensuring that facilities and equipment are in working order.

• Equipment need to be maintained and repaired on a regular basis to keep them functioning well ,thereby reducing downtime









Good maintenance removes variability. Systems must be designed and maintained to reach the expected performance.



Regular maintenance activities ensure that machines are working well without any problems thus guaranteeing quality production.



Maintenance includes inspection activities on equipment. Regular inspections can reduce the failure rate of equipment.



Maintenance activities help to reduce equipment malfunctions, thus enabling the organization to reduce the cost repairs.



With proper and regular maintenance, equipment is kept in good order which reduces the probability of accidents at the workplace



a. BREAKDOWN MAINTENANCE :

Only repairing equipment if it breaks down or stops functioning. Involves performing maintenance activities *after* a machine breakdown or malfunction has occurred and then must be repaired on an emergency or priority basis. Includes repairs, replacement of parts, or even overhaul to ensure the machines is put back in operating conditions.

b. PREVENTIVE MAINTENANCE :

Involves performing maintenance activities *before* the equipment fails. The objectives of preventive maintenance are to reduce the frequency and severity of interruptions to production caused by machine malfunctions.

CHAPTER 8 QUALITY MANAGEMENT



Quality and Strategy

Managing quality supports differentiation, low cost, and response strategies.

Quality helps firms increase sales and reduce costs.

Ensure that company produce goods and services that meet standards or specifications.

Building a quality organization is a demanding task.

Two Ways Quality Improves Profitability



The Flow of Activities



Defining Quality

An operations manager's objective is to build a total quality management system that identifies and satisfies customer needs.

"Quality can be defined as the ability of a product or service to meet the customers 'need"



Implications of Quality

Company Reputation	*Perception of new products *Employment practices *Supplier relations			
Product liability	Reduce risk			
Global implications	Improved ability to compete			

Costs of Quality

- Prevention costs reducing the potential for defects
- Appraisal costs evaluating products, parts, and services
- Internal failure costs producing defective parts or service before delivery
- External failure costs defects discovered after delivery

Costs of Quality



Quality Improvement

Eight (8) Dimensions of Quality (Goods)

1. Performance

Product can perform its function, according to the customers' intended use.

2. Reliability

- Prefers to the length of time that a product continues to function under normal conditions, before it break down or needs repairs.
- Low-quality products do not last long and will break down before the end of the normal product life pan and quality product are more long-lasting and can even outlast the normal product life span.

3. Durability

• To extent which a product's functions can withstand rough use or adverse conditions.

Eight (8) Dimensions of Quality (Goods)

4. Esthetic characteristics

• Refer to the appearance of a product; its look, fell, taste, smell or sound.

5. Safety

 Product is safe for use by consumers. Quality products have high-security features and cause no harm to the consumers.

6. Customer service

 Services received by the customer before, during and after any purchase.

7. Features

 The special qualities of the product that can attract customers.

8. Serviceability

 The ease or convenience of getting repair services, replacement of parts and after-sales services.

Total Quality Management

- TQM refers to emphasis on quality that encompasses the entire organization, from the suppliers to customers.
- Involve the entire staff of the company, from the lower-level staff such as general workers to the top management
- TQM provides strategies to reduce the causes of poor quality, thus, increases productivity



1. Continuous Improvement

- Never-ending process of continual improvement
- Covers people, equipment, materials, procedures
- Every operation can be improved
- Kaizen describes the ongoing process of unending improvement
- TQM and zero defects also used to describe continuous improvement



2. Six Sigma

- Two meanings :-
 - Statistical definition of a process that is 99.9997% capable, 3.4 defects per million opportunities (DPMO)
 - A program designed to reduce defects, lower costs, save time, and improve customer satisfaction
- A comprehensive system for achieving and sustaining business success.

Six Sigma

- 1. **Defines** the project's purpose, scope, and outputs, identifies the required process information keeping in mind the customer's definition of quality
- 2. Measures the process and collects data
- 3. Analyzes the data ensuring repeatability and reproducibility
- 4. Improves by modifying or redesigning existing processes and procedures
- 5. Controls the new process to make sure performance levels are maintained


3. Employee Empowerment

- Getting employees involved in product and process improvements
 - 85% of quality problems are due to process and material
- Techniques
 - 1) Build communication networks that include employees
 - 2) Develop open, supportive supervisors
 - 3) Move responsibility to employees
 - 4) Build a high-morale organization
 - 5) Create formal team structures

QUALITY CIRCLE

 Group of employees who meet regularly to solve problems. Trained in planning, problem solving, and statistical methods. Often led by a facilitator.

4. Benchmarking

Selecting best practices to use as a standard for performance

- 1. Determine what to benchmark
- 2. Form a benchmark team
- 3. Identify benchmarking partners
- 4. Collect and analyze benchmarking information
- 5. Take action to match or exceed the benchmark

Internal Benchmarking

- ➤When the organization is large enough
- ➤Data more accessible
- ≻Can and should be established in a variety of areas

5. Just-in-Time (JIT)

- JIT cuts the cost of quality
- JIT improves quality
- Better quality means less inventory and better, easier-to-employ JIT system
- Pull' system of production scheduling including supply management
 - Production only when signaled
- Allows reduced inventory levels
 - Inventory costs money and hides process and material problems
- Encourages improved process and product quality

Reducing inventory reveals problems so they can be solved



6. Taguchi Concepts

- Engineering and experimental design methods to improve product and process design
 - Identify key component and process variables affecting product variation
 - Taguchi estimated that as many as 80% of defective goods are caused by poor product design.
- Taguchi Concepts
 - Quality robustness-Ability to produce products uniformly in adverse manufacturing and environmental conditions
 - Quality loss function-Shows that costs increase as the product quality moves away from what the customer wants

7. TQM Tools

Tools for Generating Ideas

- Check Sheet
- Scatter Diagram
- Cause-and-Effect Diagram
- Tools to Organize the Data
 - Pareto Chart
 - Flowchart (Process Diagram)
- Tools for Identifying Problems
 - Histogram
 - Statistical Process Control Chart

(a) Check Sheet: An organized method of recording data

		Hour							
Defect	1	2	3	4	5	6	7	8	
А		/		/	/	/		/	
В		/	/	/					
С	/						//		

(b) Scatter Diagram: A graph of the value of one variable vs. another variable



Absenteeism

(c) Cause-and-Effect Diagram: A tool that identifies process elements (causes) that might affect an outcome



(d) Pareto Chart: A graph to identify and plot problems or defects in descending order of frequency



(e) Flowchart (Process Diagram): A chart that describes the steps in a process



(f) Histogram: A distribution showing the frequency of occurrences of a variable



Repair time (minutes)

(g) Statistical Process Control Chart: A chart with time on the horizontal axis to plot values of a statistic



Service Quality

The Operations Manager must recognize:

- ► The tangible component of services is important.
- ► The service process is important.
- The service is judged against the customer's expectations.
- Exceptions will occur.

DETERMINANTS OF SERVICE QUALITY

Reliability involves consistency of performance and dependability

Responsiveness concerns the willingness or readiness of employees to provide service

Competence means possession of the required skills and knowledge to perform the service

Access involves approachability and ease of contact

Courtesy involves politeness, respect, consideration, and friendliness

Communication means keeping customers informed and listening to them

Credibility involves trustworthiness, believability, and honesty

Security is the freedom from danger, risk, or doubt

Understanding/knowing the customer involves making the effort to understand the customer's needs

Tangibles include the physical evidence of the service

Exercises

QUESTION 1 sesi 2: 2022/2023

a) Describe THREE (3) objectives of layout planning.

(6 marks)

b) A facility layout is the physical location of the various department, units, workstations and equipment within the premises of facility. Elaborate THREE(3) basic layout patterns.

(9 marks)

c) A good process strategy will help the processes flow better, which will impact the overall operations management. Ascertain FOUR(4) classification of process strategy

(10 marks)

QUESTION 2

Cheezy Delight is a local brand fast-food restaurant with five branches in Southern Malaysia. The owner is planning to expand the business with the opening of the sixth branch to be in northern Malaysia. Among the intangible factors, proximity to market is the most important factor, followed by labor availability and community service. The least important is transportation system.

	Location				
Intangible Factor	Kangar	Alor Setar	Bayan Lepas		
Labor availability	Very good	Fair	Good		
Proximity to market	Good	Outstanding	Good		
Community Service	Poor	Very Good	Very Good		
Transportation system	Good	Good	Very Good		

The rating for each factor is as follows:

Outstanding	Very Good	Good/	Fair	Poor
5	4	3	2	1

a) By referring to the above information, you are required to choose the best location based on intangible factors

(10marks)

b) The table below shows the First Quarter 2021 Sales for Jaguhan Motor Sdn Bhd

Month	Sales
January	4000
February	3800
March	4110

i. Analyze a three week Moving Average forecast for the sales of Jaguhan Motor Sdn Bhd in April.

ii. Jaguhan Motor Sdn Bhd Operation Manager has assigned weights of 0.60 to the most recent sales demand, 0.30 to the sales demand one month ago and 0.10 to the sales demand the two months ago. Figure out the weighted moving average sales demand forecast for April.

(3 marks)

c) Demand for gold at Power Gold are as follows:

Month	Gold Sales (in thousands		
	kg)		
January	40		
February	46		
March	58		
April	52		
May	59		
June	51		
July	60		
August	63		

As a newly-hired operation executive, the management would like you to:

i. Analyze a forecasting model for monthly gold demand using simple linear regression analysis.

(8 marks)

i. Find demand for September and October by using the forecast model.

(2 marks)

QUESTION 3

a) The data below represents the results of a time study observation of an operator. Assembling machine parts.

Job element	Obse	ervatio	ons tim	Performance rating		
1	10	11	12	11	12	110
2	12	14	13	25	12	105
3	20	21	32	21	22	100
4	30	32	34	32	54	95

Based on the information given, you are required to simplify the normal time (NT) for each element.

(7 marks)

b) Barista Manufacturing uses 35 000 units of component Y per annum. The ordering cost is RM 18 per order and the annual carrying cost is 8% of the unit price. The price per unit is RM 12. The supplier has recently offered a new price structure to the company.

Quality purchased (units)	Price Per Unit (RM)
1-1999	12
2000-2999	10
3000-3999	8.80
4000 and above	8.50

i. Write TWO (2) types of costs that are involved in inventory management.

(2 marks)

ii. Calculate the optimal number of orders.

(2 marks)

iii. Calculate the number of orders placed each year.

iv. Compute the expected time between orders.

c) Based on the table 1, calculate the best order quantity that will minimize the total annual inventory cost

(10marks)

QUESTION 4

CantiqJelita Sdn Bhd. owns the data needed to complete work on a project at Lasah Perak farm. The company's Assistant Project Manager CantiqJelita Sdn Bhd. Based on the above information:

Activity	Immediate	Optimistic	Most likely	Pessimistic
	Precedence	Time	Time	Time
	Activities	(Month)	(Month)	(Month)
Α	-	0	2	4
В	-	2	5	2
С	-	4	2	0
D	А	0	4	2
E	В	4	8	6
F	В	1	5	3
G	С	2	6	4
Н	D,E	6	7	2
l I	F,G	3	7	5
J	H,I	8	9	4

(2marks)

(2marks)

a) Find the time required to complete each activity

b) Construct the PERT networks for this project

c) Illustrate the critical path and time for the project to be completed

QUESTION 1 sesi 1: 2022/2023

- (a) State SIX (6) objectives of layout decision. [6 marks]
- (b) Layout is one of the key decisions that determines the long run efficiency of operations. Explain the layout patterns below:
- i. Fixed position layout [3 marks]
- ii. Product layout [3 marks]
- iii. Process layout [3 marks]
- (c) Process strategy concerns with the ability of an organization to use the resources available to produce outputs. Provide an explanation of FOUR (4) process strategies that can be applied in an organization. [10 marks]

(5marks)

(10marks)

(10marks)

a) Find the time required to complete each activity

b) Construct the PERT networks for this project

c) Illustrate the critical path and time for the project to be completed

(10marks)

(5marks)

(10marks)

QUESTION 1

- (a) State SIX (6) objectives of layout decision. [6 marks]
- (b) Layout is one of the key decisions that determines the long run efficiency of operations. Explain the layout patterns below:
- i. Fixed position layout [3 marks]
- ii. Product layout [3 marks]
- iii. Process layout [3 marks]
- (c) Process strategy concerns with the ability of an organization to use the resources available to produce outputs. Provide an explanation of FOUR (4) process strategies that can be applied in an organization. [10 marks]

• QUESTION 2

(a) ABC company produces tomato sauce. The company intends to expand its operations to three different locations which are Ipoh, Arau, and Jitra. The following table are annual operating cost (RM'000).

Tangible factors/ Location	Labour	Raw materials	Transportation
Ipoh	50	45	40
Arau	48	38	42
Jitra	52	47	45

You are required to choose the best location decision based on your calculation of tangible factors.

(b) Iman's Café believes that the cost of latte coffees influences demand. The information below was compiled by Iman using historical observations to illustrate how many of these coffees were sold over different prices values.

Price (RM)	11.50	11.90	12.90	10.90	14.50
Unit Sold	50	55	48	42	48

Determine the number of coffee to be sold based on trend projection (linear regression method) if the price per cup were RM9.90. [10 marks]

(c) Sales of tablet computers at RNZ electronic store in Taman Saikat, Ipoh over the past 10 weeks are shown below:

Week	1	2	3	4	5	6	7	8	9	10
Demand	22	20	27	35	26	28	35	20	24	26

- i. You are required to explore the forecast for week 11 by using method of Naive approach.ii. Four weeks Moving Average
- iii. Exponential smoothing using a=0.5. Given the initial forecast for week six is 25.

[1 mark] [3 marks] [6 marks]

QUESTION 3

(a) The data in the following table represents a time study observation for an assembly process at RKY toy factory. The factory allows workers to have 30 minutes of personal time, 10% process allowance and 30 minutes for contingency. Assume 8-hour workday and 5 days of work per week.

Element	Performance rating (%)	Observations (minutes)						
		1	2	3	4	5		
1	110	1.8	1.2	1.4	6.2	1.5		
2	95	2.4	2.2	2.6	2.8	2.9		
3	120	1.8	2.3	2.6	2.2	2.7		
4	98	3.6	3.3	9.6	3.7	3.1		

Based on the information above, you are required to simplify the calculation of:

i.	The allowance factors	[3 marks]
ii.	The normal time for each element.	[5 marks]
iii.	The standard time for the process	[2 marks]

(a) Annual demand for a black pen at NHM Stationary Shop is 5000 units. NHM operates its business 300 days per year and finds that deliveries from its supplier generally takes 5 working days. You are required to calculate the reorder point for the black pen. [5 marks]

(b) Blue Chip Computers Company purchases 32,000 units of component Z per annum. The ordering cost is RM35 per order and the annual carrying cost is 15% of the unit price. Rich Bell Manufacturing decides to offer price dealings to attract larger orders. The price structure is shown in the table.

Quantity Purchased	Price per unit
1-1999	9.8
2000-2999	9.5
3000 above	8.9

Compute the order quantity that will minimize the annual inventory cost.

[10 marks]

QUESTION 4

- (a) In order to make sure that facilities and equipment are in good operating order maintenance is required. Explain FIVE (5) importance of maintenance.
 [10 marks]
- (b) Malaiqa is developing a program in supply chain management certification for managers. Malaiqa has listed several activities that must be completed before a training program could be conducted. The activities are described by the following table.

Activity	Immediate Predecessors	Time (Days)
А		2
В		5
С		1
D	В	8
E	A,D	5
F	С	6
G	E,F	5
Н	G	4
l I	G	3
J	H <i>,</i> I	2

You are required to draw an appropriate PERT network

(c) Based on the answer in (b), you are required to determine:

i.The earliest event time and latest time for the project.

ii. The completion time for the project .

[5 marks]

[9 marks]

[1 marks]

END OF QUESTION

ABOUT THE AUTHORS



NUR AIN BINTI MAHAT

Lecturer at Commerce Department at Politeknik Tuanku Sultanah Bahiyah Kulim , Kedah . She holds a Bachelor Degree in Business Administration (Operations Management) (Hons) and Master of Business Administration.



SITI MARIAM BINTI SAMAT

Lecturer at Commerce Department at Politeknik Tuanku Sultanah Bahiyah Kulim , Kedah . She holds a Bachelor Degree in Business administration (Human Resource) (Hons) and Master in Technic and Vocational Educational(TVED).

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