UNIVERSITY OF MINDANAO
Tagum College

College of Business Administration Education
Human Resource Management Program

Physically Distanced but Academically Engaged

Self-Instructional Manual (SIM) for Self-Directed Learning (SDL)

Course/Subject: CBM 112/ Operations Management with TQM

Name of Teacher: **RAIZA MAE C. NARCISO, PhD**

THIS SIM/SDL MANUAL IS A DRAFT VERSION ONLY; NOT FOR REPRODUCTION AND DISTRIBUTION OUTSIDE OF ITS INTENDED USE. THIS IS INTENDED ONLY FOR THE USE OF THE STUDENTS WHO ARE OFFICIALLY ENROLLED IN THE COURSE/SUBJECT.
EXPECT REVISIONS OF THE MANUAL.

DEPARTMENT OF BUSINESS ADMINISTRATION EDUCATION
Human Resource Management Program
Mabini Street, Tagum City
Davao del Norte
Telefax: (084)655-9591 Local 116

Table of Contents

Course Outline : CBM 112 –C ons Management with TQM

Course Coordinator:	**Dr. Raiza Mae C. Narciso**
Email:	**raiza_narciso@umindanao.edu.ph**
Student Consultation:	By appointment
Mobile:	0933-820-1418
Effectivity Date:	June 2020
Mode of Delivery:	Distance Education Learning (DED)
Time Frame:	54 Hours
Student Workload:	Expected Self-Directed Learning
Requisites:	BAHR 211
Credit:	3
Attendance Requirements:	A minimum of 95% attendance is required at all scheduled Virtual or face to face sessions.

Course Outline Policy

Areas of Concern	Details
Contact and Non-contact Hours	This 3-unit course self-instructional manual is designed for distance education delivery mode with 54 expected number of hours, which includes the scheduled virtual sessions and online conduct of learning exercises. The virtual class shall consist of a question and answer session from students with concerns regarding the topic via google meet.
Assessment Task Submission	Submission of assessment tasks shall be strictly observed based on the course schedule at the bottom of this SIM. Assessment will be given via www.quipper.com. Specific instructions will be given per assessment. Thus, you are required to create an account at Quipper.

Turnitin Submission	To ensure honesty and authenticity, all research assignment tasks are required to be submitted through ***Turnitin*** with a maximum similarity index of 30% allowed. This means that if your paper goes beyond 30%, you will either opt to redo your paper or explain in writing addressed to the course coordinator the reasons for the similarity or you may be called for a disciplinary action in accordance with the University's OPM on Intellectual and Academic Honesty. Please note that academic dishonesty such as cheating and commissioning other students or people to complete the task for you have severe punishments (reprimand, warning, expulsion).
Penalties for Late Assessments	If you were not able to submit exercises on time and should you want to ask for an extension due for some important reasons, you shall make a letter of request for extension which is subject for approval from your course coordinator. You will also be required to present/attach evidences which is necessary to strengthen your request. Once approved, the score will be reduced by 5% from the possible highest points if the learning exercises was submitted late.
Return of Assessments	Assessment tasks shall be returned to you two (2) weeks after the deadline of submission. This will be returned through quipper portal.
Assignment Resubmission	You should request in writing addressed to the course facilitator your intention to resubmit an assessment task. The resubmission is premised on the student's failure to comply with the similarity index and other reasonable grounds such as academic literacy standards or other reasonable circumstances e.g. illness, accidents financial constraints.

Re-marking of Assessment Papers and Appeal	You should request in writing addressed to the course coordinator your intention to appeal or contest the score given to an assessment task. The letter should explicitly explain the reasons/points to contest the grade. The course coordinator shall communicate with the complainant on the approval and disapproval of the request. If disapproved by the course coordinator, you can elevate your case to the program head then the dean with the original letter of request. The final decision will come from the dean of the college.
Grading System	Submission of the final grades shall follow the usual University system and procedures. **Class Participation – 30%** - Quizzes/Assignments Participation (10% - Research, Projects and Requirements (20%) **1st – 3rd Examination – 30%** **Final Examination– 40%** **Total – 100%**
Preferred Referencing Style	You are required to use the general practice of the Harvard Referencing Style. The sample will be uploaded in the quipper portal.
Student Communication	You are required to create a *student quipper account at* ***www.quipper.com***. Then, the course coordinator shall provide code for you to access the materials and resources of the course. All communication formats: chat, submission of assessment tasks, requests etc. shall be through the portal and other university recognized platforms. Also, google meet will be used as an official means for your scheduled virtual sessions. Thus, you are required to use the official umindanao account as much as possible. Normal communication and announcement shall be via FB messenger, the course facilitator shall create a Group Chat within the first week of the start of the class. You can also meet the course facilitator in virtual through the scheduled virtual sessions to raise your issues and concerns.

Contact Details of the Dean	**Gina Fe G. Israel, EdD** Smart:0909-994-2314 deansofficetagum@umindanao.edu.ph
Contact Details of the Program Head	**Raiza Mae C. Narciso** Email: raiza_narciso@umindanao.edu.ph Mobile: 09338201418
Students with Special Needs	If you are a student with special needs, you shall communicate with the course coordinator about the nature of your special needs. Depending on the nature of the need, the course coordinator with the approval of the program head may provide alternative assessment tasks or extension of the deadline of submission of assessment tasks. However, the alternative assessment tasks should still be in the service of achieving the desired course learning outcomes.
Video Conference	You are required to use the google meet for the scheduled video conferencing. Please note that it is pre-scheduled. Please refer to the course schedule given by your subject teacher.
Help Desk Contact	**Dean's Office** Globe:09158325092 Smart: deansofficetagum@umindanao.edu.ph **Business Administration Education** Globe: 09955870420 Smart: 09107045559 FB page: UM Tagum College – DBAE **Cashiering Office** Globe: 09458941623 Smart: 09494254457 Sun: 09336032028 **Records and Admission Center** Globe: 09752634831 / 09151825490 rac.tagum@umindanao.edu.ph **Student Accounts Office** Smart: 09075135112 / 09755119982 saotagum@umindanao.edu.ph
Library Contact	0927-395-1639

DEPARTMENT OF BUSINESS ADMINISTRATION EDUCATION
Human Resource Management Program
Mabini Street, Tagum City
Davao del Norte
Telefax: (084)655-9591 Local 116

Course Information – *see/download course syllabus in the Black Board LMS*

CC's Voice: *Hello prospective business practitioners! Welcome to this course CBM 112: Operation's Management with TQM. By now, I am confident that you really wanted to become a successful business professional and that you have visualized yourself already doing business in your own specific field of expertise.*

CO: *Before the actual business practice, you have to deal with several challenges that needs the application of appropriate tools or methods for basic productions and operations scenarios and solve actual business problems through the use of quantitative and qualitative tools and techniques which are the course outcomes of this subject. This particular subject shall dicuss the nature, scope and limitation, and importance of Operations, Production, and Total Quality Management in a business entity. This comprise topics on productivity, project management, forecasting, decision making environment, and Total Quality Management. Specific cases/problems will be given to actualize and internalize your comprehension of the topic for easy understanding*

Let us begin!

Big Picture A

Week 1-3: Unit Learning Outcomes (ULO): At the end of the unit, you are expected to

a. Introduce and discuss operations Management and Productivity; and
b. Discuss the Global Environment and Identify the different Operations Strategy in an International Environment.

Big Picture A in Focus: *ULOa.*
a. Introduce and Discuss Operations Management and Productivity

Metalanguage

In this section, the most essential terms relevant to the study of production management and to demonstrate ***ULOa*** was operationally defined and discussed in the essential knowledge to establish a common frame of reference as to how the texts work in your chosen field or career. You will encounter these terms as we go through the study of production management. Specific discussion per topic shall be provided in the later part

to help you understand more about the scope in studying this course. There will be computation as well, formula and sample was also provided to guide you in answering the exercises in this unit.

1. **Production.** Production is the creation of goods and services.
2. **Productivity.** The concept refers to the amount of outputs (goods and services) divided by inputs (like labor and capital resources).
3. **Single-factor productivity.** Indicates the ratio of one resource (input) to the (output) generated products and services.
4. **Multi-factor productivity.** Indicates the ratio of many or all resources (inputs) to the products and services (outputs) produced.

Essential Knowledge

To perform the aforesaid big picture (unit learning outcomes) for the first week of the course, you need to fully understand the following essential knowledge that will be laid down in the succeeding pages. Please note that you are not limited to exclusively refer to these resources. Thus, you are expected to utilize other books, research articles and other resources that are available in the university's library e.g. ***ebrary, search.proquest.com etc.***

1. **Hard Rock Café.** This multi-national company is a world class restaurant which later diversify its business to gaming, hotel, and casinos. Hard Rock Café was built in the year 1971, it was the best dining restaurant in London due to its unique themed food services which gives customers a rock and roll ambiance.
   - **1.1** This rock and roll themed restaurant prepares and customized over 3,500 meals every day. Hard Rock Café in Orlando, Florida, is one of the largest restaurants in the world. Despite the demands of the customers, the operations manager in HRC is incredibly competitive which consistently serve the "hot food hot and the cold food cold".
   - **1.2** Having an efficient work layout and process are just some of the priorities of the Operations Manager in HRC. This may also be the reason of the employee's effective and efficient work job. Operations and Production related process was carefully and meticulously checked by the managers to ensure that the food was served right on time with correct measures, temperatures etc.
   - **1.3** In 1979, the famous singer Eric Clapton once visited the cafe and due5 to its delight he gave his guitar as memorabilia to show satisfaction and delight of the restaurant magnificent dining experience. Ever since, the idea on covering its walls with rock and roll memorabilia commence. Many icons/artist who visited the place did the same and left valuables to the café, which paves its way to become a Restaurant with mini museum with valuable things hanging at the wall. Some known artist was Madona/Michael Jackson etc.
   - **1.4** The secret for maintaining its reputation lies in the effective work lay-out set by the operations manager considering process from grilling, baking, frying, and

more of it, which helped in ensuring quality in any aspect of service and goods served to its customers.

1.5 Operations management is complex, difficult and exciting. It's impacting our daily lives. The operations managers basically decide how well we live.

2. **Operations Management.** To define the operations management, it is a sequence of activities that generate value by transformation of inputs into outputs in the form of products and services.

2.1 **Production.** Production is the creation of goods and services.

3. **How to organize the production of goods & services.** Business entities always considered the 3 major function that are vital in the creation of goods and services. Most of its operation are primarily focused in these departments. These are considered to be a vital key for productivity as well as in surviving organizational competition.

3.1 **Marketing function**. This department/function primarily concerns the identification, advertising and penetrating existing or target market. Thus, this function is vital as it generates the demands of the product.

3.2 **Production/Operation function**. Obviously, without this the company does not have anything to sell. This function mainly concerns the Creation of the product.

3.3 **Finance/Accounting function**. This function tracks the inflow and outflow of the company finances which concerns the payment of bills, collection of money and many others.

4. **Why Study Operations Management?** Good Om managers are scarce and as a result, career opportunities and pay are excellent. There are four major reasons why studying OM is essential for businesses:

4.1 Operation's Management belongs to the 3 major functions. Thus, it's essentially to know basic function of it since it's related to all.

4.2 In order to know how goods and services are created and produced.

4.3 Operations manager always encounter challenges which requires decision making, to understand them studying OM will be very helpful.

4.4 In business most specially in manufacturing industry and services Operations Management holds a big portion of budget and deciding matters on where to cut cost and other decision is vital.

5. **Major Task of the Operation's Manager.** All managers still go back in doing the 5 distinct process of management known as POSDICON.

5.1 **Planning**. This function tackles about the setting of objectives, long-term/ short-term plans, company policy, operations and procedures which aims to attain the goals of the company.

5.2 **Organizing** – This refers to grouping of the different organizational resources particularly the 6M's which includes men, money, machineries, market, method, and moment.

5.3 **Staffing**. This is a highly HR function that particularly targets on "putting the right person in the right job".

5.4 Directing – This function concerns topic on Leadership, Motivation, and Communication. This is a difficult function since you are dealing with people which is highly unpredictable.

5.5 Controlling – The last process is about assessment and evaluation of the other 4 distinct process to ensure conformity to the plans being set.

5.6 There are 10 major decision areas that an operation manager must. An effective manager can be able to address these 10 decision areas to the best of his/her knowledge. The job of an Operation Manager is very demanding and challenging indeed.

10 Decision Areas	Issues
1. Design of goods & services	What goods/services should we offer? How should we design these products?
2. Managing quality	How do we define quality? Who is responsible for quality?
3. Process & Capacity design	What process & what capacity will these products require? What equipment & technology is necessary for these processes?
4. Location Strategy	Where should we put the facility? How large must the facility be to meet our plan?
5. Layout strategy	How should we arrange the facility? How large must the facility be to meet our plan?
6. Human resources & job design	How do we provide a reasonable work environment? How much can we expect our employees to produce?
7. Supply-Chain Management	Should we make/buy this component? Who should be our suppliers & how can we integrate them into our strategy?
8. Inventory, material requirements planning & JIT	How much inventory of each item should we have? When do we reorder?
9. Intermediate & short-term scheduling	Are we better off keeping people on the payroll during slowdowns? Which job do we perform next?
10. Maintenance	How do we build reliability into our processes? Who is responsible for maintenance?

6. Difference Between Goods and Services.

CHARACTERISTICS OF SERVICES	CHARACTERISTICS OF GOODS
Intangible: Ride in an roller coaster	Tangible: The coaster itself
Produced and consumed simultaneously: Coffee Shop selling Frappe that is consumed as it is	Product can usually be kept in inventory (beauty care products)

Unique: Your investments and medical care are unique	Similar products produced (iPods)
High customer interaction: Often what the customer is paying for (consulting, education)	Limited customer involvement in production
Inconsistent product definition: Auto Insurance changes with age and type of car	Product standardized (iPhone)
Often knowledge based: Legal, education, and medical services are hard to automate	Standard tangible product tends to make automation feasible
Services dispersed: Service may occur at retail store, local office, house call, or via internet.	Product typically produced at a fixed facility
Quality may be hard to evaluate: Consulting, education, and medical services	Many aspects of quality for tangible products are easy to evaluate (strength of a bolt)
Reselling is unusual: Musical concert or medical care	Product often has some residual value

7. **Challenges in Productivity.** In creating goods and providing of services, several issues or challenges will be encountered which requires decisions relating to operations and production. Other may use the cost-benefit analysis or even the opportunity cost to address such challenges.
   7.1 Some of the productivity challenge may include how to reduce input/raw materials while output remains the same or how to maximize output if there are no changes in input.
8. **Starbucks improvement in productivity.** Starbucks is known for providing a world-class service with quality products. The brand itself always connotes a quality goods and services that many coffee shops imitate. As part of continuous improvement, the company conducted study and form 10 team of analyst that studies ergonomics or process efficiency on how to save time in their operations to cater the customer quickly which later leads to satisfaction. Part of the changes they did are the following:
   8.1 For purchases under $25 dollars, they do not require a signature on credit card transactions: By this, they were able to save 8 seconds per credit card transactions.
   8.2 The team created an ice scoop that is equivalent to 1 order per drinks to save time in scooping ice one by one: This saved 14 seconds per drink
   8.3 Instead of having a barista they bought an expresso machine to automate process: They were able to save 12 seconds per shot.

8.4 Despite the improvements made, Starbucks' Services and Development boosted total sales per store from $250,000 to $1,000,000 in seven years. Productivity has increased by 27% or around 4.5% per annum.

9. Measurement in Productivity. Measuring productivity in operation helped manager in identifying how effective the process is. Understanding productivity is vital in improving our quality of life.

9.1 Productivity. The concept refers to the amount of outputs (goods and services) divided by inputs (like labor and capital resources). Referring to this, let us remember that productivity relates to output in the manufacture of goods and does not imply the production amount of a given product.

9.2 Single-factor productivity. Indicates the ratio of one resource (input) to the (output) generated products and services. Refer to the computation bellow:

Productivity = Units Produced/Input Used

9.3 Multi-factor productivity. Indicates the ratio of many or all resources (inputs) to the products and services (outputs) produced; This is the Multi-factor productivity formula for computing:

Productivity = Units Produced/ Labor + Material + Energy + Capital + Miscellaneous

9.4 Change in Productivity. To measure the exact percentage of change in productivity, the formula below is used:

% Δ = New Productivity – Old Productivity / Old Productivity

Example: Through a modern computerized title-search program, Collins Title needs to determine the labour and multi-factor productivity. The business has a workforce of four, each operating eight hours per day (for a $640 / day payroll cost) and $400 annual overhead expenses. Collins manages & finishes every day on eight names. The new computerized title-search program would require 14 titles to be searched every day. Also if the workers, their hours of service, and salaries remain the same, the payroll costs are still $800.

Solutions:

Using single-factor productivity:

- **Old Labor Prod.** = 8 titles per day / 32 labor-hrs = **.25 titles/labor-hr**
- **New Labor Prod.** = 14 titles per day / 32 labor-hrs = **.4375 titles/labor-hr**
- **% Δ** = .4375 - .25 / .25 = ***.75 or 75% change***

Using multi- factor productivity:

- **Old MFP** = 8 titles per day / $640 + 400 = **.0077 titles/dollar**
- **New MFP** = 14 titles per day / $640 + 800 = **.0097 titles/dollar**
- **% Δ** = .0097 - .0077 / .0077 = ***.2597 or 25.97% change***

10. Variables in Productivity. Changes in productivity are dependent on three products variable. If you want productivity to improve you must take note of the following factors and focus attention on improving such variable. In a survey

conducted, the following result was the percentage of influence that such variable contributes to productivity:

10.1 **Labor.** 10% of the improvement in productivity annually is caused by the Human Resources working in the company. Labor contributes about 10% of the annual increase. Labor productivity is a result of a good employee-employer relationship, communication, and continuous learning.

10.2 **Capital.** 38% of the improvement in productivity is caused by capital investment. Business competition has been very stiff in this information technology age, investment in Technology, advance equipment, system and others are necessary to adopt in this highly competing environment. Improvement in Labor is also caused by Capital, giving them advance an updated tools or means in doing job can help them improve their performance.

10.3 **Management**. 52% of the improvement in productivity is caused by management leaders. Top and Middle management are responsible for decisions involving the other two variables. Result of their decision or even their leadership affects the business entirely. Dealing with people and analyzing the connection of investing such capital is a big factor in the increase of productivity. Thus, a large percentage of influence for the improvement of productivity is caused by management.

Self-Help: You can also refer to the sources below to help you further understand the lesson:

* Heizer, J. and Render, B. (2011). *Principles of Operations management*. 10th edition. Upper Saddle River, NJ: Prentice Hall, pp 33-51.

* Schroeder, R. G., Goldstein, S. M. and Rungtusanatham, M. J. (2017). *Operations management in the supply chain: decisions and cases.* 7TH edition. New York, NY: McGraw-Hill Education, pp 2-15.

Let's Check

QUIZ EXERCISE 1. Now that you know the most essential terms in the introduction of production management. Let us try to check your understanding of these terms. In the space provided, write the term/s being asked in the following statements (10 pts):

_____1. Often produced and consumed simultaneously.

_____2. Activities linked to the production of products and services, through turning inputs into outputs.

_____3. Indicates the ratio of one resource (input) to the goods & services produced (outputs).

_____4. A variable that contributes about 38% of the annual increase.

_____5. Refers to the creation of goods & services.

_____6. Hard Rock Café in Makati City was established in what complete date?

_____7. Grouping together of people, establishing relationship among them, and defining the authority and responsibility the personnel have in the use of the company's material resources to attain predetermined goals and objective.

_____8. Indicates the ratio of many or all resources (inputs) to the goods and services produced (outputs).

_____9. Process of measuring and correcting the activities of subordinates and the company itself to assure conformity to plans.

_____10. The ratio of outputs (goods and services) divided by the inputs (resources such as labor and capital).

QUIZ EXERCISE 2. Write **TRUE** if the statement is Correct and write **FALSE** if it is incorrect (10 points).

_____ 1. Hard Rock Café in Orlando, Florida , prepares over 1,500 meals each day.

_____ 2. The use of productivity measures aids manager in determining how well they are doing.

_____ 3. The formula in measuring productivity is Input / Output used.

_____ 4. The marketing function creates goods and services.

_____ 5. Productivity improvements are easy to achieve.

DEPARTMENT OF BUSINESS ADMINISTRATION EDUCATION
Human Resource Management Program
Mabini Street, Tagum City
Davao del Norte
Telefax: (084)655-9591 Local 116

Let's Analyze

ASSIGNMENT 1. Getting acquainted with the computations in the topic productivity. Now, I will require you to solve the problem given considering the requirements.

PROBLEM: Klaus Mikaelson makes Volleyballs in his New Orlean plant. He has a renewed belief in productivity with recent increases in the prices. Klaus had an interest in assessing his organisation 's profitability. He would like to ask if his business achieves an annual production gain of three percent in manufacturing. He has the following details reflecting a month from last year, and this year's corresponding month.

	Last Year	**Now**
Units produced (Volleyballs)	1,000	1,000
Labor (hours)	300	275
Pounds (lbs.)	50	45
Capital interest ($)	10,000	11,000
Energy (BTU)	3,000	2,850

REQUIREMENT (Place your solution for each category per box below):

1. Compute for the productivity of each category (up to 4 decimal point per answer). Show your solution

2.Compute for the productivity percentage change for each category (up to 4 decimal point per answer). Show your solution.

3. Does the organization maintain the manufacturing average of 3% increase in productivity? Elaborate your answer.

In a Nutshell

The study of production management is indeed a pre-requisite to becoming a successful business practitioner. It is a very complicated and demanding task which requires patience and technical expertise including knowledge outside the classroom and school.

Based from the definition of the most essential terms of production management and the learning exercises that you have done, please feel free to write your arguments or lessons learned below. I have indicated my arguments or lessons learned.

1. Business practitioners must have basic knowledge on the five management function process: Planning, Organizing, Staffing, Directing, and Controlling (POSDICON).
2. Argue which is the best measurement of productivity: Single-factor or Multi-factor? Single-factor productivity is often used especially in the service sector. Measuring labor productivity has been very important since human resources are considered as one of the main reasons of its increase/decrease. However, Multi-factor

productivity is a holistic approach in measuring productivity since it does not consider one input

but multiple inputs over time. Thus, it is very helpful as it results to achieve an objective decision.

Your Turn

3. _____

_____

_____

Q&A LIST.

In this section, you may list down all emerging questions or issues to help you in your review of concepts and essential knowledge. Answers will be specifically tackled in the scheduled video conferencing.

Do you have any Questions or clarifications?	
Questions/Issues	**Answers**
1.	
2.	
3.	

KEYWORDS INDEX.

Management Process/Function	*Operations Management*	*Single-factor Productivity*	*Multi-factor Productivity*
Products	*Project Manager*	*Production*	*Products*
Planning	*Organizing*	*Staffing*	*Directing*
Labor	*Capital*	*Management*	*Controlling*
Goods	*Services*	*Operations Manager*	

Big Picture A in Focus: ULOb.

b. Discuss the Global Environment and Identify the different Operations Strategy in an International Environment

Metalanguage

For you to understand ***ULOb***, you will need to have an idea of the Global Company Profile: Boeing. This international company is a best example on how Boeing's Global Strategy yields competitive advantage.

1. **Mission.** The purpose or rationale for an organization's existence.
2. **Strategy.** The organization's action plan to achieve the mission. Firms achieve mission in three conceptual ways: *Differentiation, Cost leadership, and Response.*
3. **International Business.** Refers to companies that venture in international trade or investment.
4. **Multi-national corporation.** It a firm with significant presence in multinational markets, operates or manages assets in more than one nation.
5. **International Strategy.** This firms involve in exporting and importing to expand business in an international setting.
6. **Multi-domestic strategy.** Operations of this firms are highly decentralized, his is highly sensitive to the culture and styles of the country where it operates.
7. **Global Strategy.** Opposite to Multi-domestic global strategy operation is centralized no matter what country you are in.
8. **Transnational Strategy.** This is the best strategy yet the costliest one, this is a combination of global and multi-domestic strategy where standardization of process is maintained but local responsiveness was also focused on.

Essential Knowledge

Before you proceed further with the topic, it is highly important to rationalize discussion on the global view of operations, developing missions and strategies, achieving competitive advantage through operations, issues in operations strategy and global operations strategy options.

1. **Operation in a Global Setting.** Thinking globally should be the mindset of all operation's managers at this time. In 1990s, a lot of problem was seen as hindrance in improving productivity and these are: religions, ethnicity, colors politics, and even cultural barriers. Gone are the days were discrimination is prevalent that affects the productivity of the people working in a certain company.

The creation of Boeing 787 dreamliner is considered as one of the best strategy applied both in global and engineering perspective. This breakthrough in manufacturing and engineering raises the bar in supply chain management. The 787 dreamliner acquired a record breaking sales dues to its state-of-the-art design branded as fast-selling commercial jets in history;

Using a virtual work station allows Boeing engineers to coordinate and collaborate in real time even if sub-parts were made in other countries including partners in Australia, Japan, Italy, Canada, and across the Unites States. Digital testing was used in identifying errors before the actual production per sub-part of the dreamliner;

Lastly, after digital testing, the parts were shipped at Everest Washington for the final assembly;
35% of the Dreamliner was built by Japanese suppliers and others were distributed from different countries. This implies that the trust of several Multi-national companies in Japan is huge due to their robust design and quality product which is vital in ensuring quality output; and

Therefore, domestic production is not anymore viable for Global companies in this Globalized era. Many Businesses also considered other strategies in expanding the market, exporting/importing is already an old strategy, venturing multi-domestic, global, and transnational strategy for multi-national company is the new normal.

2. Traditional method of operation is already outdated many engineers, scientist, and business practitioners have challenged the old ways of doing things. Business operation highly evolved for a better a fast process. Globalization therefore has direct impact in company's improvement in their product, extending services throughout the market and offering something new to satisfy people's insatiable needs. A production that takes how many days, weeks, or months to accomplish can now be produced in minutes, hours or days considering the concept of the economies of scale. However, globalization strategies might give competitive advantage to the company but it also complicates the work of the operation's manager. That is why Operation Manager is one of the highest paid job nowadays because work is very demanding.
3. Various reason was identified why local business operation shift to international or global operation. These are:
   3.1 Cost Reduction. A lot of companies engage in global operation to reduce cost and take advantage of the opportunity. Aside from that companies can

also purchase raw materials directly in other country at a lesser cost with high quality.

3.1.1 Labor cost is one of the variables that needs to be focused on and some countries like Philippines, China, and other Asian Countries offer lesser cost of labor than in developed countries.

3.1.2 trade agreements have aimed to eliminate taxes and therefore to decrease the costs of running facilities abroad:

3.1.2.1 **World Trade Organization (WTO).** An international organization that promotes world trade by lowering barriers to the free flow of goods across borders;

3.1.2.2 **North American Free Trade Agreement (NAFTA).** A free trade agreement between Canada, Mexico, and the United States;

3.1.2.3 **Maquiladoras.** Mexican factories located along US – Mexico border that receive preferential tariff treatment; and

3.1.2.4 **European Union (EU).** A European trade group that has 27 member states.

TRIVIA ► U.S. CARTOON CHARACTERS WERE CREATED IN MANILA

Around 90% of U.S. televised cartoon were created by Filipinos to name some of it are: FRED FLINSTONE, TOM & JERRY, ALADIN, and DONALD DUCK. Filipinos are flexible in adapting other country's culture plus the familiarity and expertise in the universal language paved way to be one of the outsourced labor in Asian countries. Filipinos are also liked by foreign country due to its talents, character, and intelligence.

Disney, Marvel, Warner Brother and Hanna-Barbera are the major universal studios that outsourced Filipinos to create storyboards and sketches per episode and voice tracks to the Philippines. Approximately, 20,000 sketches were drawn for a 30-minutes episode. These giant companies were able to save a lot of labor cost from $500,000 dollars if US made to $130,000 if Philippine-made or $160,000 if Korean-made.

Sources: *Journal of Global Information Technology Management* (2007): 1-6; *The New York Times* (February 26, 2004): A29; and the *Wall Street Journal* (August 9, 2005): D8.

3.2 Supply Chain improvement. Going near to the main source of supply is also a wise move for most companies, they were able to save shipping fees and other costs involve in raw materials acquisition.

3.2.1 Auto mecca of Southern California were known for its world-class auto styling studios in which most companies move there to learn auto-design;

3.2.2 China is famous for its cheap production costs thus some known athletic shoe like Nike transferred from South Korea to China to save labor and production cost;

3.2.3 Grasse, France is where the world's best essences was located. Most known Perfume manufacturer has outlet or plant in there to acquire in close contact the flowers in the Mediterranean which are used to extract essence for perfumes.

3.3 Provide an Improve Product. Going global permits companies to understand the culture of other countries inspiring them to innovate and improve current existing product. Foreign markets can also be a tool to discover something new in your business thereby contributing in a new and improved version of your goods and services.

3.4 Understand Markets. Competition can lead to new opportunities. Due to hypercompetition companies thrives to be better with its rival at all times. With this, opportunity from service providers are also sufficient. Same with supply chain improvement the following examples was also noted due to understanding market competition:

3.4.1 Japan was known for its robust design and quality products. Thus, a lt of Cell phone manufacturers outsourced computer aided design (CAD) and computer aided manufacturing (CAM) in Japan.

3.4.2 For developed country like Japan, product life cycle works differently compared to developing countries. Thus, engaging global operations can also be a tool to extend the product life cycle of an existing product. Example, a declining cellphone edition in Japan might be an introductory edition in the Philippines. So instead of junking it why not sell it to developing countries to make more profit out of it;

3.4.3 As discussed OM job becomes more demanding because of the different variations in lifestyle, culture and economic activity in every county. Thus understanding each is vital, for instance, Whirlpool designs washing machines with dry washers in countries with four seasons while in tropical country it's optional. Likewise, refrigerators in some Asian country like India or Bangkok were in bright colors because it was displayed at the living room which became part of their decorations while in others colors are in white, black, or cream.

3.5 Continuously Learn to Improve Operations. Learning is like a race with no finish line. It's fluid and allow a free flow of ideas.

3.5.1 When it comes to product design and inventory management Japanese and Scandinavians are so good at that. In ergonomics, designing product must always aim in making our life better, the connection of the design and on how we use it must be beneficial to the customer considering not to waste time and save motion.

3.5.2 The international operations will boost customer satisfaction and response time.

3.6 **Attract and Retain Global Talent.** Potential employees can be kept intact if companies gave them opportunities to grow and develop their potentials. Wasting such talents is a big loss to global companies, in going global one needs a highly competitive human resources also to understand well what's happening in the bigger picture.

4. **Mission and Strategy Development.** It is uncommon for companies to set a mission and develop a strategy. To continue business operation, setting the preliminaries are vital because every decision must be anchored in the big picture.
   - 4.1 **Mission.** The purpose or rationale for an organization's existence.
   - 4.2 **Strategy.** The organization's action plan to achieve the mission. Firms achieve mission in three conceptual ways: *Differentiation, Cost leadership, and Response.*
5. **Conceptual ways in achieving mission.** These strategies paved way for companies to stay on track and develop its competitive edge over others:
   - 5.1 **Competitive Advantage.** Something that you have that others do not have. It is also something about the product leader that you have or the best service that you offer that others cannot or do not give.
   - 5.2 **Differentiation.** This strategy can also be matched with the competitive advantage that you have. Adding value to the product is a tool to attain such edge. This is attributed to the customer's transcendent perspective in viewing your product, the uniqueness and may go into both physical and service characteristics. Exceeding customer's perception of value.
   - 5.3 **Cost Leadership.** This is about offering product in a just price. It does not imply cheap prices for a product but it tackles about the relationship with quality and cost. Using Cost Leadership does not imply low quality because it particularly targets mass market, acquiring quality and affordable product.
   - 5.4 **Response.** It is normal for a company to experience post-purchase services and responding timely to customer's concern is highly relevant. A lot of company also cater to the specific needs of the customer in which response strategy can be used in maintaining customer satisfaction.
6. **Global Operations Strategy Options.** Nowadays, companies that settle in traditional business operation are associated with less sale records as compared to a global firm. Going global does not always mean selling product outside the country but also means improving product using global operations.
   - 6.1 **International Business.** Refers to companies that venture in international trade or investment.
   - 6.2 **Multi-national corporation.** It a firm with significant presence in multinational markets, operates or manages assets in more than one nation.
   - 6.3 **International Strategy.** This firms involve in exporting and importing to expand business in an international setting. In the Philippines, this is very

common in agricultural products were DOLE or SUMIFRU engages in such activities. This has little local responsiveness and little cost advantage.

6.4 Multi-domestic strategy. Operations of this firms are highly decentralized, his is highly sensitive to the culture and styles of the country where it operates. Example is the leading fast food chain in the world, McDonalds. This Restaurant offers variety of menu depending on the country they are in. For instance, Mcdonalds in France offers wine, beer in Germany, Teriyaki in Japan etc. The strategy has high local responsiveness with little or no cost advantage.

6.5 Global Strategy. Opposite to Multi-domestic global strategy operation is centralized no matter what country you are in. This is common in BPOs in which they just expanded their business operation to ot her country. This has significant cost reduction but little local responsiveness.

6.6 Transnational Strategy. This is the best strategy yet the most costly one, this is a combination of global and multi-domestic strategy where standardization of process is maintained but local responsiveness was also focused on. The best sample for this is the Boeing 787 dreamliner were parts were made across boarders but maintain business operation standard at home country. This strategy has significant cost reduction and significant local responsiveness.

Self-Help: You can also refer to the sources below to help you further understand the lesson:

* Heizer, J. and Render, B. (2011). *Principles of Operations management*. 10th edition. Upper Saddle River, NJ: Prentice Hall, pp 59-79.

* Schroeder, R. G., Goldstein, S. M. and Rungtusanatham, M. J. (2017). *Operations management in the supply chain: decisions and cases.* 7TH edition. New York, NY: McGraw-Hill Education, 18-32.

Let's Check

QUIZ EXERCISE 3. Please encircle the letter of your correct answer that best reflects your thinking (10 points).

1. A mission statement is beneficial to an organization because it:
   a. is a statement of the organization's purpose.
   b. identifies important constituencies.
   c. Details specific income goals.
   d. ensures profitability.
2. The three strategic approaches to competitive advantage are _____, _____, and _____.
   a. international, mutidomestic, and transnational strategy
   b. response, cost leadership, and differentiation
   c. response, global, and multidomestic
   d. mission, strategy, and competitive advantage
3. A company that is organized across boundaries, with decentralized authority and substantial autonomy at each business via subsidiaries, franchises, or joint venture has:
   a. a global strategy c multidomestic strategy
   b. a transnational strategy d. international strategy
4. The purpose or rationale for an organization's existence.
   a. Vision b. Goals c. Mission d. company philosophy
5. A Global Operations Strategy that produces goods considering the cultural background of the country.
   a. International Strategy c. Multidomestic Strategy
   b. Transnational Strategy d. Global Strategy

Let's Analyze

RESEARCH EXERCISE 1 - Provide your own discussion in the blank spaces. This activity will be rated according to the rubrics below:

Note: Answer will be rated per item/requirement including references (5-point is the highest – total of 25 points)

1. Based on the description and analysis for this topic, would Boeing be better described as a global firm or a transnational firm? Discuss.

Answer:

_____

_____

_____

_____

_____

_____

2. There are three primary ways to achieve competitive advantage. Provide an example not included in the text for each, support your choices (use APA format 6th edition in proper citation and referencing).

Answer:

Differentiation _____

_____

_____

_____

_____

_____

_____

_____

Cost Leadership _____

_____

_____

_____

_____

_____

Response _____

_____

_____

_____

_____

_____**Refere**

nce

In a Nutshell

The importance of understanding the global environment and operations strategy is vital. In this unit, you will be required to state your arguments or synthesis relevant to the topics presented. I will supply the first two items and you will continue the rest.

1. For many organizations, the operations function provides the competitive advantage.
2. The operation's manager job is to implement an OM strategy, provide competitive advantage, and increase productivity.

Your Turn

3._____

_____

4._____

_____

_____

Q&A LIST.

In this section, you may list down all emerging questions or issues to help you in your review of concepts and essential knowledge. Answers will be specifically tackled in the scheduled video conferencing.

Do you have any Questions or clarifications?	
Questions/Issues	**Answers**
1.	
2.	
3.	

KEYWORDS INDEX.

Multi-national Corporations	*International Business*	*Productivity Variables*	*World Trade Organization*
Goods	*Productivity*	*Maquiladoras*	*Mission*
Production	*Services*	*Differentiation*	*Strategy*
Cost Leadership	*Response*	*European Union*	*Global Strategy*

International Strategy	*Multi-domestic Strategy*	*Transnational Strategy*	*Competitive Advantage*
North American Free Trade Agreement	*Products*	*Project Manager*	*Production*

Week 4-5: Unit Learning Outcomes (ULO): At the end of the unit, you are expected to

a. Identify the importance of Project Planning, Scheduling, and Controlling; and
b. Rationalize the concept of Network Techniques: PERT/CPM.

Big Picture B in Focus: *ULOa.*
a. identify the importance of Project Planning, Scheduling, and Controlling

Metalanguage

In this section, the most essential terms relevant to the study of project management and to demonstrate ***ULOa*** will be discussed. No matter what profession you are in the ability to manage a project effectively is necessary since project is naturally formulated once in a while. Remember that the outcome of your project can make or break your company in general thus, it is a necessity to learn project management. Encountering Challenges are just normal in project management, delays, fortuitous event, demanding customer/client are just some of it but knowing how to manage it may lessen the problem on planning, scheduling, and controlling. In this unit, you will learn of the three phases of managing the projects, these are:

- ***Planning.*** Planning refers to the phase where goals, project description and project team are planned/formulated. This is a crucial phase because output is dependent on the input that you used, meaning task, labor, materials and others shall be planned well for a smooth implementation;
- ***Scheduling****:* This phase tackles about the organization of the 6M's of management (men, money, market, machinery, method, market, and moment). Success in project management also depends on how you handle well this organizational resources; and
- ***Controlling:*** The last phase of project management yet the most challenging one. Normally, when a project is near to its end, common bottlenecks will be encountered (lack of supplies, budget constraints, client's change of mind, project behind schedule) and a sudden shift in client decision's like fast tracking the completion of project are usually common. At this phase, project manager should be adaptive to the demands of time, so revising plan is not common at this phase but as to how much cost and least time a project can be shorten were just some of the questions that needs to be addressed in here.

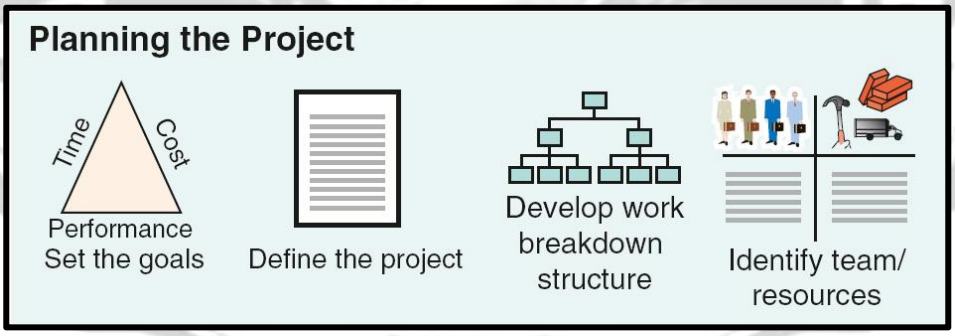
Essential Knowledge

To discuss the aforesaid big picture (unit learning outcomes) for the next three (3) weeks of the course, you need to fully understand the following essential knowledge

that will be laid down in the succeeding pages. Please note that you are not limited to exclusively refer to these resources. Thus, you are expected to utilize other books, research articles and other resources that are available in the university's library e.g. ***ebrary, search.proquest.com etc.***

1. **PLANNING A PROJECT.** Project is temporary in nature and it can refer to a set of related activities that targets a specific outcome. For this to realize, big firms formulate a **project team organization** that will focus on conducting the 3 phases of project management. They are tasked to monitor the day-to-day operation of the project; special attention will be given to such project until the very end of the project. Below are the specific activities done in this phase:

   In relation, there are four famous methods that project managers used in the 3 different phases, these are: Work Breakdown Structure, Gannt Chart, PERT and CPM. The Project Management Institute (PMI) stated that "a project is a temporary endeavor undertaken to create a unique product, service or result." First to note here is that project has a start and finishing activities; project are not continuous with no end because it's just temporary. Thus, project management requires a different approach and attention in managing as compared to normal operation in business.



1.1 Project Organization. This is a team developed to assure that project planning, scheduling, and controlling are well taken care of. Again, this is just a temporary team unless a certain firm creates a particular unit tasked to handle different projects, this is headed by a project manager which is responsible in monitoring from the entire duration of project.

1.2 Project Organization Works Best when:

- Task will be specifically identified specially when objectives/goals are set using the mnemonic SMART (Specific, measurable, achievable, realistic, and time-bounded);
- Task is not common and routinary to the usual operation of the business;

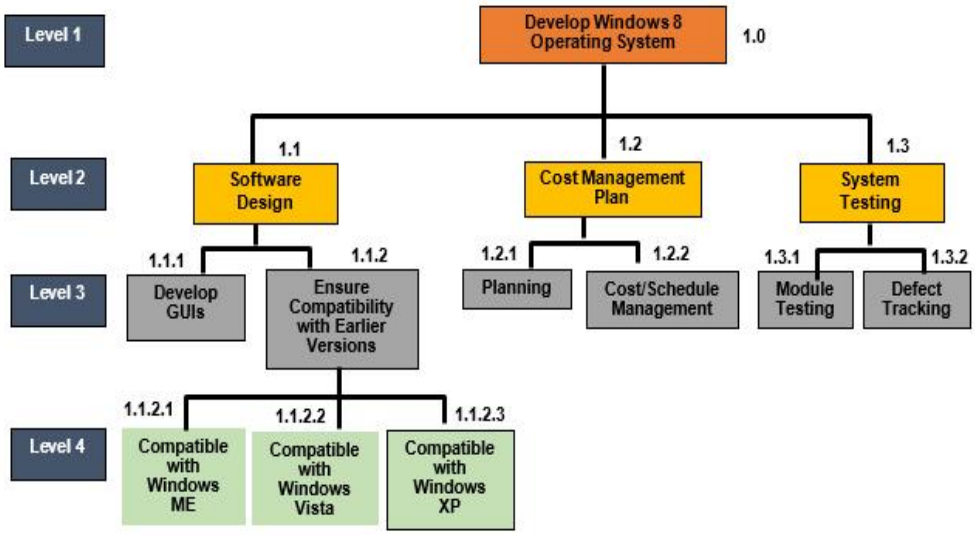
- Task involves complicated interrelated job that requires some unique skill set; and
- project is related at all units in the organization.
- **Project Manager's Role.** The role of project manager encompasses all the necessary attributes that a good manager should have. This is a demanding job since the outcome of the project can make or break the company itself. They should be a good mentor with overflowing patience, has good interpersonal skills, and should have a know-how of the different fields that can be affected in the project operations. Most specially, a Project manager should be accessible to everyone, and ensuring that:
- Task are accomplished on schedule;
- Budget are not compromised and fit;
- Quality is not sacrificed despite the deadline and cost of raw materials; and
- Human resources must always be treated with utmost respect, they must feel valued, and motivated so that they will take pride in whatever task given to them.

2. **Work Breakdown Structure.** One of the method used in Project planning that portrays a ranked task of a project specifying the detailed activities of the major task. Project team starts its job by identifying possible task that shall be undertaken to complete the project.

2.1 Splitting up the project into bits and pieces can be hard, yet it is crucial in project management and scheduling. At this stage, materials, people, and cost are also estimated by the team.

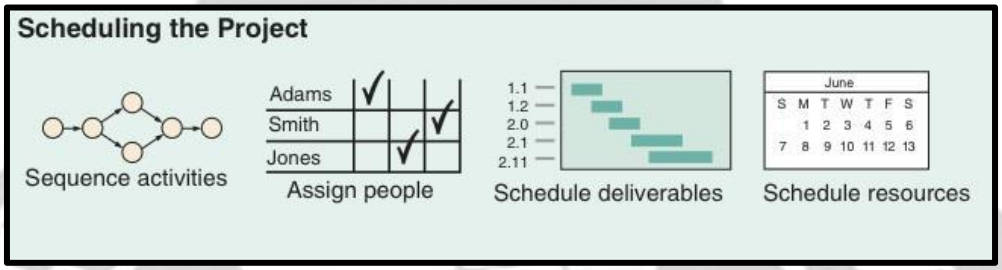
2.2 WBS usually declines in size from highest to bottommost and is portrayed like the one below:

Level
1 Project
2 Major Task in the project
3 Subtasks in major tasks
4 Activities (or "work packages") to be completed



Note: In order to create a WBS, use the Level ID as guide. In the assessment, Level ID with Work description will be arranged together in a table in random order.

3. **Project Scheduling.** In this phase, it ensures that the entire task was planned, their connectivity is checked and estimated time of completion considering the best, worst and the safest are identified. Some activities include:



3.1 Purposes of Project Scheduling. Whatever means that a project manager used in completing the project, scheduling a project displays:

- The connectivity of all activities from beginning to end;
- The precedence relationships of the activties;
- Inspires the identification of time and cost estimates in a realistic setting; and
- Aids in managing the organizational resources (5Ms) by identifying bottlenecks.

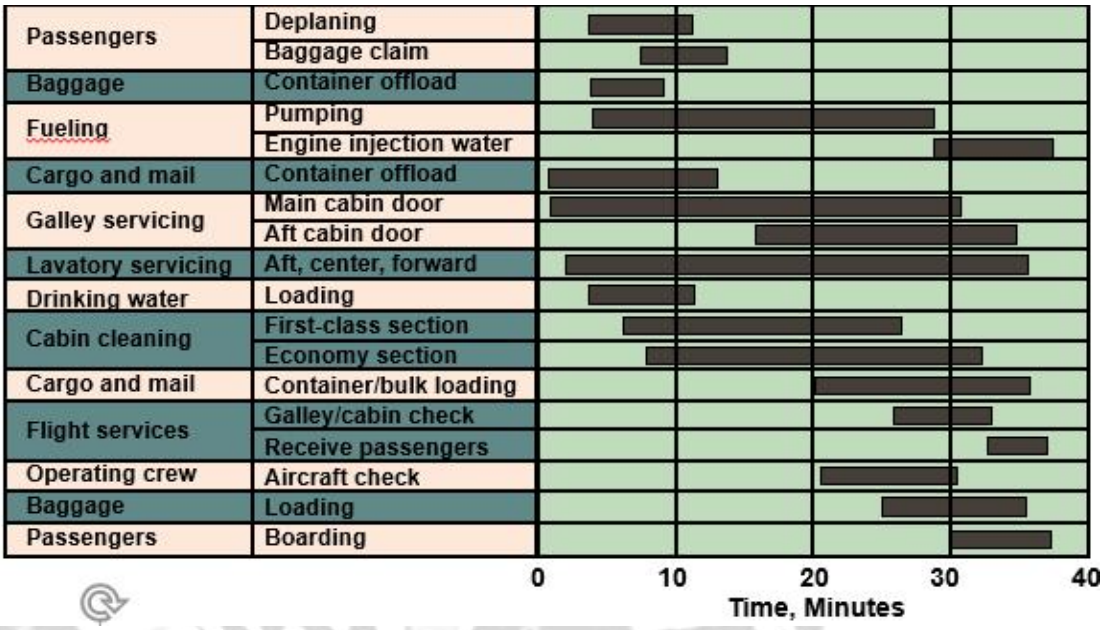
3.2 Gantt Chart. Charts of preparation used to plan organizational resources and assign time. This was developed by Henry L. Gantt which became popular due to low-cost means of helping managers make sure that:

- Task are premeditated;
- The execution order has record keep;
- Expected time of completion is logged; and
- Entire project time completion is formulated.

Below is an illustration of a routine servicing of a Delta jetliner during a 40-minute layover which can be used for scheduling repetitive operations. In this

The University of Mindanao

case the chart helps points out potential delays.



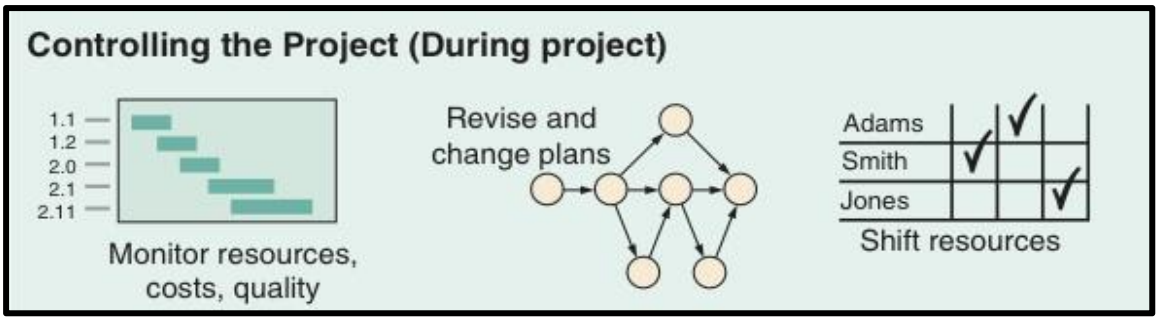
4. **Controlling of the Project.** Controlling is part of the basic management functions and it's always the last process or phase since it involves assessment or evaluation of the activity or project. This contains the following activities like monitoring organizational resources, project costs, and project schedule. Regular assessment enables the project team to give recommendations on the possible revisions, status, and shifting of resources.

4.1 This phase yields the following reports:

- Breakdown of normal and crash cost for every activity;
- labor productivity;
- tables of the distribution of cost;
- Work Costs and timetable summary;
- Expense/Expenditure report or forecast
- Reporting of variances;
- Analyzing and reporting Timeline; and
- Status of work update.

The University of Mindanao

Below show several activities done for



Controlling. Further discussions of the technique used will be discussed in ULOb.

Self-Help: You can also refer to the sources below to help you further understand the lesson:

* Heizer, J. and Render, B. (2011). *Principles of Operations management*. 10th edition. Upper Saddle River, NJ: Prentice Hall, pp 90 - 94.

* Schroeder, R. G., Goldstein, S. M. and Rungtusanatham, M. J. (2017). *Operations management in the supply chain: decisions and cases.* 7TH edition. New York, NY: McGraw-Hill Education, 263 - 268.

Let's Check

QUIZ EXERCISE 4. Encircle the letter that best describes the answer (10 points).

1. Which of the following statements regarding Gantt Charts is true?
   a. Gantt charts give a timeline and precedence relationships for each activity of a project
   b. Gannt Charts use the four standard spines: Methods, Materials, Manpower, and Machinery
   c. Gantt Charts are visual devices that show the duration of activities in a project
   d. Gantt Charts are expensive

The University of Mindanao

2. When a firm monitors resources, costs, quality, and budgets which may result to making necessary revisions or shifting of resources in order to meet time and cost demands, the firm is under which specific phase of managing a project?
   a. Planning
   b. Controlling
   c. Forecasting
   d. Scheduling
3. Below are activities done in Scheduling a project, EXCEPT;
   a. Assigning People
   b. Schedule Deliverables
   c. Scheduling Resources
   d. Shifting of Resources
4. Which among the activities listed below would fall under planning the project?
   a. Developing Work Breakdown Structure
   b. Shifting Resources
   c. Sequencing Activities
   d. Monitoring
5. Planning charts used to schedule resources and allocate time.
   a. PERT
   b. Gantt Charts
   c. CPM
   d. Work Breakdown Structure

Let's Analyze

ASSIGNMENT EXERCISE 2 - Work Breakdown Structure (20 points)

Instruction: Create two WBS using the data below.

Answer (Draw it in landscape format):

WBS 1		WBS 2	
LEVEL ID	ACTIVITIES/TASK	LEVEL ID	ACTIVITIES/TASK
1.2	Caps/Ground Beams	1.4	Bake
1.2.3	Concrete	1.5	Frost
1.4	External	1.1.1	Buy Dry Goods and Fresh Ingredients
1.0	Construction Master	1.0	Bake Cake
1.4.1	Cladding	1.3	Mix Ingredients
1.2.1	Cut-Off Piles and Blinding	1.4.1	Pre-Heat Oven
1.3	Structural Steel	1.1	Buy Ingredients
1.4.2	Roofing	1.4.2	Bake in Oven
1.2.2	Formwork& Rebar	1.2	Measure Ingredients
1.1	Site Preparation	1.4.3	Cool on Rack

ASSIGNMENT EXERCISE 3 – Gantt Chart (20 points)

The University of Mindanao

Instruction: Create 2 Gantt Charts using the data below

GC NO. 1		GC NO. 2	
ACTIVITIES	**TIME PERIOD (in weeks)**	**ACTIVITIES**	**TIME PERIOD (in days and months)**
1. Planning	1 – 2	1. Meetings for deciding website concept	February 11-13
2. Demolition	2	2. Meetings for decising video concept	February 11 – 13
3. Electrical/Plumbing	3 – 4	3. Research the Referennces	February 12 – 14
4. Framing/Dry Wall	4 – 5	4. Wireframe/ Moodboard/ Storyboard	February 13 – 14
5. Paint	5 – 7	5. Trace the location	February 18 – 20
6. Cabinets/Fixtures	7 – 8	6. Shooting films/ Taking Photographs	February 18 – 20
7. Doors/Surrounds	9	7. Editing and making videos/ photographs	February 21 – 27
8. Cleaning	10	8. Designing of graphics	February 15 – 16
9. Flooring	10 – 11	9. Making website using WIX	February 24 – March 6
10. Trim/Finish Work	11 – 12	10. Complete the website	March 5 - 6

Answer:

The University of Mindanao

In a Nutshell

Knowing Project Management is essential as anybody can be a project manager in a company. In this portion, you will be required to state your arguments or synthesis relevant to the topics presented. I will supply the first two items and you will continue the rest.

1. Differentiating Project to non-project must be done to effectively do the job well.
2. In making a Gantt Chart, labeling the time of completion must be written inside the cell not in the borderline in order for shading to be clear and concise.

Your Turn

3. _____

_____

_____

4. _____

_____

_____

Q&A LIST.

In this section, students may list down all emerging questions or issues to help you in your review of concepts and essential knowledge. Answers will be specifically discussed in the scheduled video conferencing.

Do you have any Questions or clarifications?	
Questions/Issues	**Answers**
1.	
2.	

KEYWORDS INDEX.

Project Management	*Work Breakdown Structure*	*Program Evaluation Review Technique*	*Project Controlling*
Gantt Charts	*Project Organization*	*Project Scheduling*	*Project Planning*

The University of Mindanao

Big Picture B in Focus: ULOb.

b. Rationalize the concept of Network Techniques: PERT/CPM.

Metalanguage

In this unit, you will learn how to use PERT/CPM technique in managing both small and large projects. Controlling Project is done by several teams which works as one. Time, cost, and performance were monitored by this team aligned in the set plan of the project. When troubles are detected, immediate corrective action are considered which includes plan revision, reallocation of budget, change in personnel, and many others. The decision to shift or change the original plan must be made realistic by the project team.

1. **Project closing** is concerned with formally ending a project.
2. **Project crashing.** Shortening the network of operation to reduce the period on the critical path, thereby decreasing overall completion time.
3. **Program Evaluation Review Technique.** A technique for project management which have three estimates of time for each task. Consider precedence relationships and interdependencies.
4. **Activity on node (AON).** A network diagram designating activities by nodes.
5. **Activity on arrow (AOA).** A network diagram designating activities by arrows.

Essential Knowledge

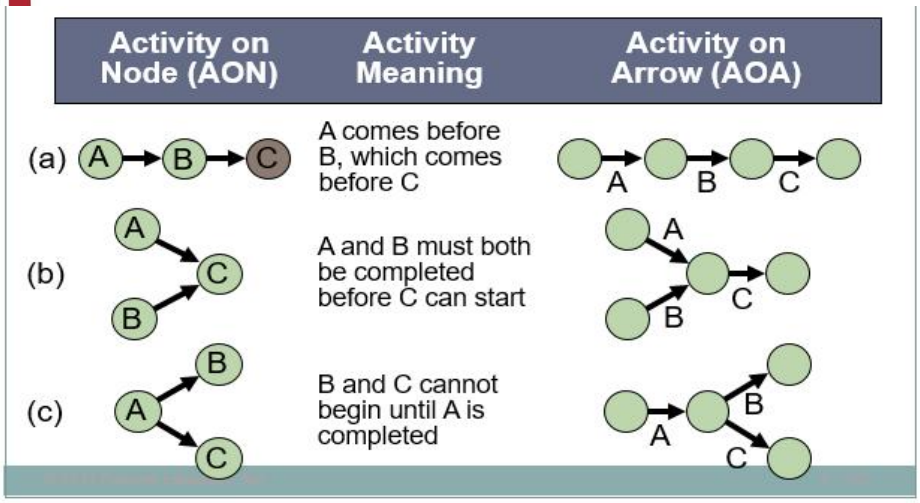
To perform the aforesaid big picture (unit learning outcomes) for the next three weeks of the course, you need to fully understand the following essential knowledge relating to the techniques used in Project Controlling. Please note that you are not limited to exclusively refer to these resources. Thus, you are expected to utilize other books, research articles and other resources that are available in the university's library e.g. ***ebrary, search.proquest.com etc.***

1. **Project Management Techniques: PERT and CPM.** The former was formulated in the year 1950s that serve as aid to several managers in scheduling, monitoring, and controlling huge and complicated project. The latter was developed first in the year 1957 as a tool formulated by J.E Kelly of Remington and M.R. Walker of DuPont for chemical plants. Autonomously, PERT was developed in 1958 by Booz, Allen & Hamilton for the U.S. Navy, for Polaris missile.
   - 1.1 **Program Evaluation Review Technique.** A technique for project management which have three estimates of time for each task. Consider precedence relationships and interdependencies.
   - 1.2 **Critical Path Method.** A technique for project management that requires only one-single factor per task.
   - 1.3 **Critical Path.** The longest time path (s) over a network computed.
2. **The Framework of PERT and CPM.** PERT and CPM both follow six basic steps:

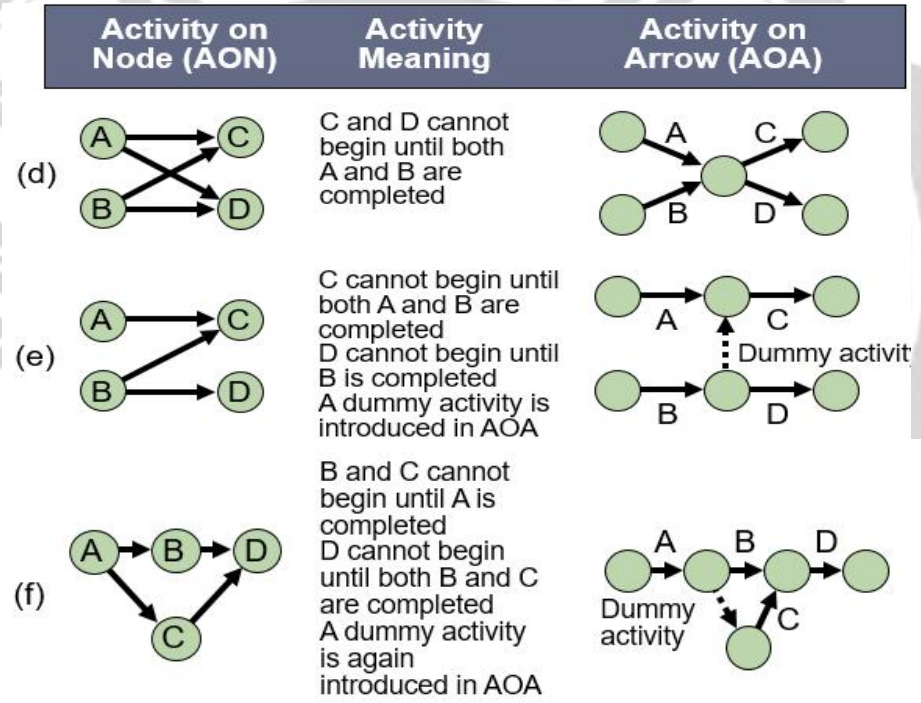
- Identifying of the project details and formulation of WBS;
- Identification of its precedence relationship;
- Illustrating the previous step by making a diagram;
- Identification of time estimates per activity;
- Identifying of the different path most especially the critical path, the longest time path through the network; and
- Utilization of the network for planning, scheduling, and monitoring/controlling the entire project.

3. **Questions PERT & CPM Can Answer.**
   - The Expected Project Completion time;
   - Critical activities and noncritical activities;
   - Specific date of completion of the project;
   - Project Status if behind, or ahead schedule;
   - Project Cost monitoring if it is equal, lesser than or greater than the budget;
   - Availability of Resources to finish the project;
   - If project will be shorten how much will be incurred in addition and what is the least time a project can be finished.
4. **Network Diagrams and Approaches.** Project Network can be done in two ways: **Activity on node (AON)** and **Activity on arrow (AOA).** To differentiate, in AON nodes represents the activities while in AOA arrows represents the activities. Thus, the nodes in AON have no time nor resources. For easy understanding, we will use the AON as our official approach in doing the PERT diagram:
   4.1 Activity on node (AON). A network diagram designating activities by nodes.
   4.2 Activity on arrow (AOA). A network diagram designating activities by arrows.
   4.3 Illustrated below are examples of AON and AOA illustration that helps you differentiate both approach.

4.4 Note



that in illustration (e) and (f) below under AOA approach provides a dummy activity (see broken arrow) just to clarify relationships.



4.5 Dummy activity. This is an activity added that don't possess any time and resources but used for the purpose of maintaining the logic of the network. In AON, two dummies are required most especially if the project has multiple star and end activities. In AON, it is portrayed using a broken/dashed arrow.

5. **Activity-on-node Example.** Notice below that to make the diagram it is important to identify the *immediate predecessors* for each activity.

PROBLEM ► Milwaukee Paper Processing, Inc., headquartered near downtown Milwaukee, has long endeavored to escape the costs of building air pollution control systems at its facility. Recently, the US Environmental Protection Agency (EPA) has given him 16 weeks to install a complex system to filter the air. Milwaukee Paper received the warning that it will have to close

The University of Mindanao

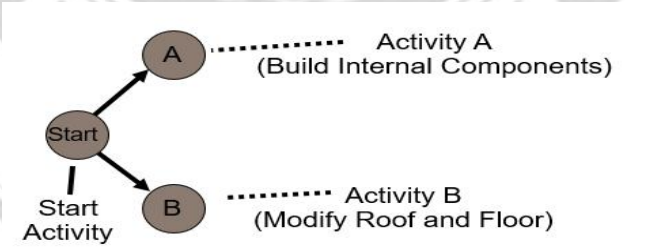
its factory unless it installs a complex system to filter the air Joni Steinberg, administrator of the plant, wants to make sure that the installation of the filtration system goes smoothly and ends on time.

APPROACH ► Milwaukee Paper has identified the eight activities that must be completed to complete the project with the time required for each activity in weeks. These appear in the table below.

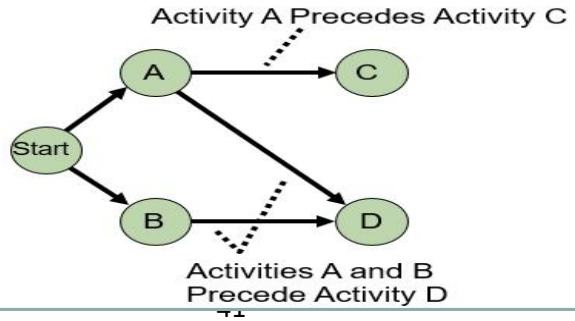
Milwaukee Paper Manufacturing's Activities and Predecessors

ACTIVITY	DESCRIPTION	IMMEDIATE PREDECESSORS
A	Build internal components	—
B	Modify roof and floor	—
C	Construct collection stack	A
D	Pour concrete and install frame	A, B
E	Build high-temperature burner	C
F	Install pollution control system	C
G	Install air pollution device	D, E
H	Inspect and test	F, G

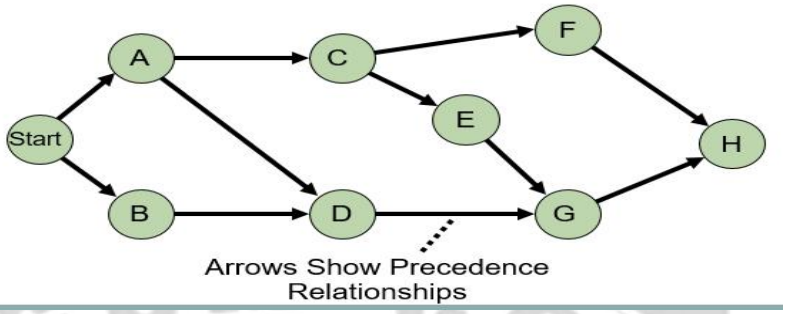
5.1 In the sample above, dashed line means having no predecessor (refer to Activity A and B). So, it means that both can start simultaneously and are connected to a dummy Start. Dummy Start is necessary in making PERT in order to clarify the beginning of the project, this actually do not exist since it's a dummy. The start activity serves as the predecessor of A and B since both doesn't have any.



5.2 Next, as based on the table, activity C succeed activity A. Thus, C must be connected to A by drawing an arrow and node. As for activity D since it has two predecessors A and B arrows must be created from both predecessors and must be connected to activity D.



5.3 Repeat the process, adding arrow from the predecessor of the activity connecting it to the activity (its successor). Displayed below is the finished AON project network of Milwaukee Paper Manufacturing.



6. **Variability in Activity Times.** In computing the estimated completion for every activity handling three-time estimate let the project manager to safely gauge the variation in finishing each of it. CPM implies that we have a set period of time for every activity and that there is no variation in the operation times.

6.1 Three Time Estimates. In PERT, the 3-time estimate was used in probability distribution:

- **Optimistic time (a)** – If everything goes according to schedule. This is the optimal completion period for operation that could be obtained in a PERT network.
- **Pessimistic time (b)** – Considering circumstances which are rather adverse. This is the "worst" period of operation that a PERT network might predict.
- **Most likely time (m)** – most realistic estimate. This is the most probable period to perform an operation inside a more reasonable approximation of a PERT network.

6.2 To compute the expected time per activity we used the formula:

$$t = (a + 4m + b)/6$$

6.3 Assign Time and Cost Estimates, using the formula above, we have:

Activity	Optimistic (a)	Most Likely (m)	Pessimistic (b)	Expected Time
A	1	2	3	2
B	2	3	4	3
C	1	2	3	2
D	2	4	6	4
E	1	4	7	4
F	1	2	9	3
G	3	4	11	5
H	1	2	3	2

The University of Mindanao

6.4 Determining the Project Schedule. After computing the estimated activity completion considering the three time estimates, this is now the time estimates for

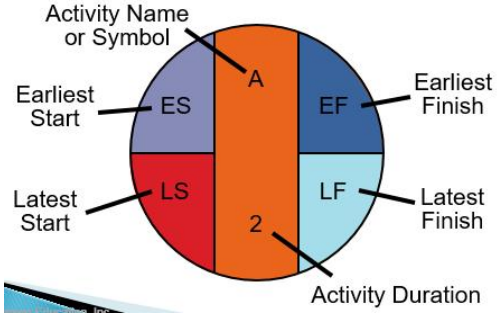
ACTIVITY	DESCRIPTION	TIME (WEEKS)
A	Build internal components	2
B	Modify roof and floor	3
C	Construct collection stack	2
D	Pour concrete and install frame	4
E	Build high-temperature burner	4
F	Install pollution control system	3
G	Install air pollution device	5
H	Inspect and test	2
	Total time (weeks)	25

Milwauke Paper Manufacturing.

6.5 Although the total time (weeks) when added equals to 25 weeks it does not entail that it can be completed in 25 weeks in general. Remember that there are activities that simultaneously started, unless the relationship is linear the project completion time is always lesser than the added time (in weeks).

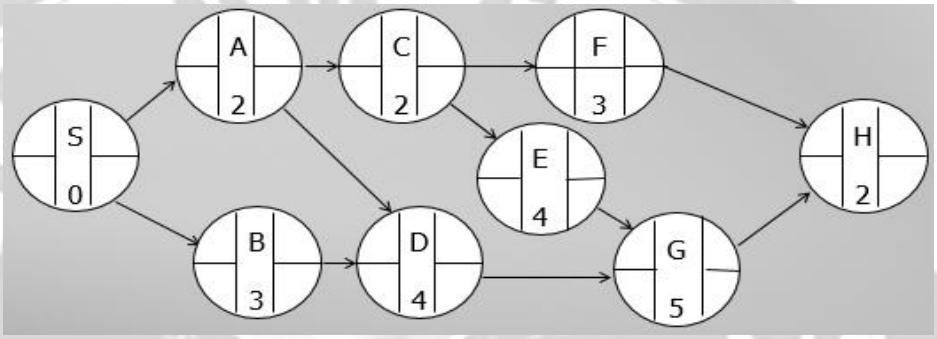
6.6 Project Schedule Determination. When you already computed the expected time completion per activity you are now ready to identify the total project computation using the forward pass and backward pass.

6.6.1 Note of the parts inside the Nodes. The Earliest time estimates are on the upper part labeled as ES and EF. The latest time estimates are at the bottom part labeled as LS and LF. Please refer to the image below:



6.6.2 Two-pass process were used in computing to evaluate certain time schedules for each operation this comprises of a **forward pass** and a **backward pass**. During the forward pass the early start and end times (ES and EF) are calculated. By computing this, you will be able to identify the project completion time of the entire project. The latest times, (LS and LF) are identified in the **backward pass.**

6.6.3 This is the illustration of the PERT networks with activities containing the activity symbol and activity duration in the Milwaukee Paper Manufacturing.



6.6.4 **Forward Pass/Earliest Start Time Rule.** This section assumes that all antecedents are accomplished accounting the earliest time that an activity can start. Immediate predecessors should be accomplished before starting the succeeding activity. Please take note of the rule in computing forward pass:

- ES = EF for activities with only one predecessor;
- For multiple predecessors, ES is the maximum of all EF values of its predecessors. That is:

ES = Max (EF of all immediate predecessor)

6.6.5 **Earliest Finish Rule.** This is the earliest time that an activity can be finished. EF is the sum of the ES and activity duration/Expected completion of the activity. That is,

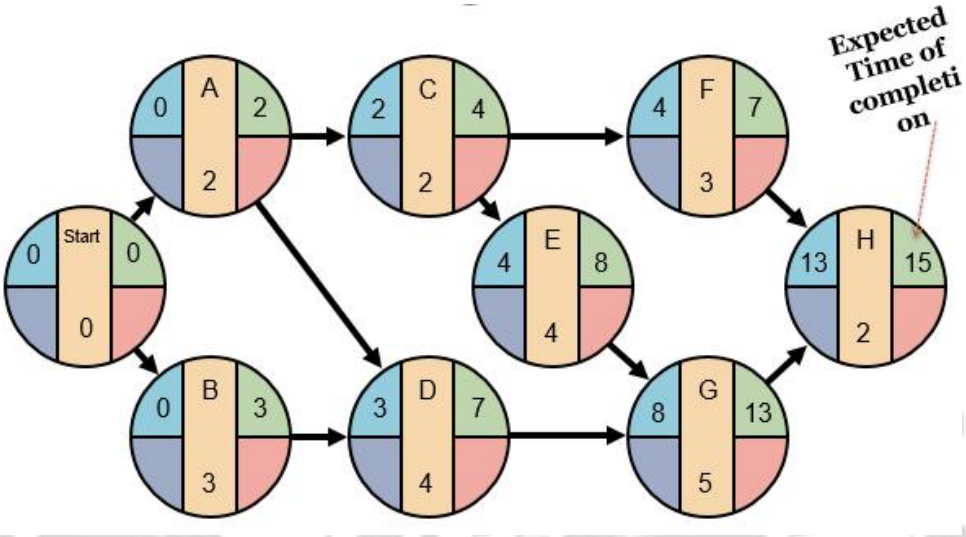
EF = ES + Activity duration

6.6.6 Shown below is an illustration for the computation using the Earliest Start time Rule. As you can see, the last EF of an activity is the number of weeks this project can be completed. In this case, Milwaukee Paper Manufacturing project will be completed within 15 weeks and not 25 weeks since there are activities that will start

sim
ulta
neo

usly. **In the case that there are two or more ending activities, the highest number shall be the ETC.**

6.6.7 Backward Pass/Latest Finish Time Rule. Opposite with how to compute using forward pass, backward pass starts with the ending



e latest finish time rule is again based on the assumption that all its immediate predecessors must be completed before an operation can begin. Do note of the following:

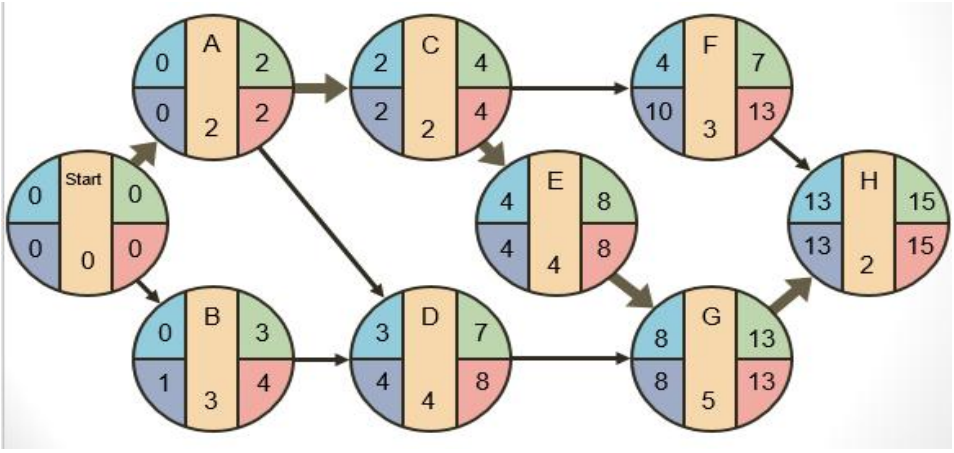
- For ending activity/activities LF is/are equal to the Project completion time of the project;
- LF is equal to the LS of its successor for single activity;
- For multiple successors, LF is equal to the minimum of the LS activities that immediately follows it. That is:

LF = Min (LS of all immediate following activities)

6.6.8 Latest Start Time rule. To compute the latest start, please refer to the formula below:

LS = LF – Activity Time

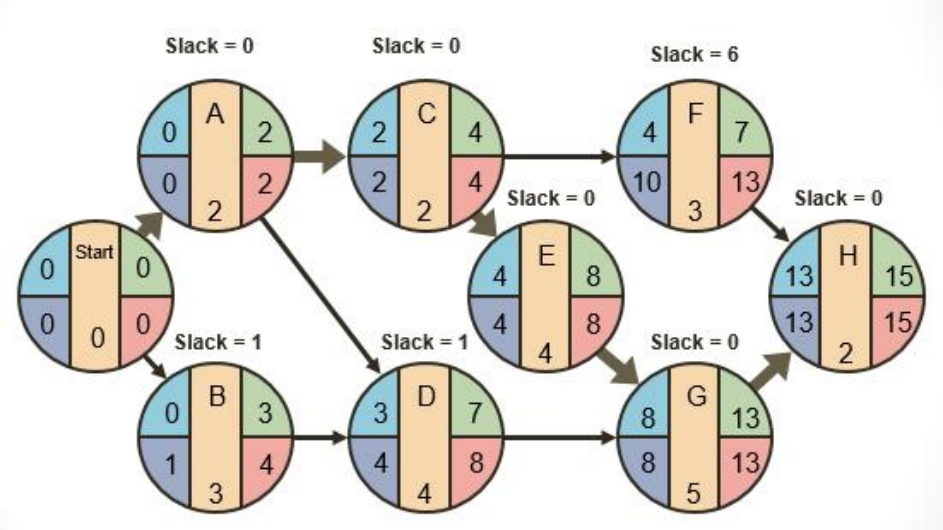
6.6.9 Shown below is the complete computation using the forward pass and backward pass as based on the formula given.



The University of Mindanao

7. **Calculating the slack time and identifying the critical Path (s).** At this point, you are now ready to identify which activity or path are critical and which is not. Completing this activity is crucial as it is the basis for Crashing the project.
   7.1 After performing the two-pass computation for the entire activity, it is time now to calculate the **slack time** for each activity**.**
   7.2 Slack Time. It applies to the permitted period to postpone an operation without stopping the whole project. Both formula below will arrive with same answer:

Slack = LS – ES or **Slack** = LF – EF



   7.3 Activities with 0 slack (A, C, E, G, and H) are called critical activities which means the project manager must closely monitor it since it does not allow any delay in the activities. Example, if activity A's completion time is 2 weeks it must be finished on or before 2 weeks because if it lapsed, the entire project will be affected, thus delaying it.
   7.4 Activity B, D, and F are called non-critical activities since their slack time is more than 0. Meaning, such activities can be delayed at its allowable time (refer to the slack time). For example, activity F has slack of 6 meaning, it is allowed to be delayed by 6 weeks without delaying the entire project. However, if an adjacent activity has a slack time, delaying the two activities at the same time is not allowed, this is what we called **Total slack**.
   7.5 Total Slack. Refers to the total slack both adjacent activity can be delayed. Refers to the total slack both adjacent activity can be delayed. Suppose activity B is postponed by 1 week, and now has an EF of 4. This indicates activity D currently has an ES of 4, and an EF of 8. Notice that these are the values for LS and LF, respectively. That is, activity D will not have a slack

period
now,
either.

Essentially, the 1-week slack that activities B and D had is exchanged with them for that direction. Delaying any activity by one week allows not only the activity to sacrifice its slack but also the other activity. Usually they exchange complete slackness as two or more non-critical events occur successively in a pathway.

7.6 Critical Path Analysis. In the result above, we can now identify several paths that are present in this network. To identify the path, just follow the arrows from starting to ending activities and to identify the weeks of completion per paths, just add the activity duration, you may refer below:

- A-C-F-H = 9 weeks
- **A-C-E-G-H = 15 weeks**
- A-D-G-H = 13 weeks
- B-D-G-H = 14 weeks

7.6.1 Referring to path A-C-E-G-H, it is called as the **critical path** because it is a continuous path across a network of projects that:

- Begins at the first activity of the project;
- Ends at the last activity in the project;
- All slack under this path is 0;
- It is the longest path through the network;
- The critical path is the shortest time in which the project can be completed; and
- Any delay in critical path activities delays the project.

7.6.2 To reiterate, for non-critical paths which has activities with slack time, delaying such non-critical activities will not delay the entire project. For example, in path **A-C-F-H**, noticed that activity F has 6 weeks' allowable delay. Thus, if activity F will be delayed, it does not affect the completion of the entire project because if:

A-C-F-H = 9 weeks + 6 weeks (delayed) **= 15 weeks**

7.6.3 For **Total slack,** noticed that path **B-D-G-H** has 14 weeks of completion. Activity B and D has 1 slack time each which is called total slack. Since the non-critical activities appear simultaneously delaying both will delay the entire project. Thus, only one week delay will be allowed for either B or D:

B-D-G-H = 14 weeks + 1 week (activity B-delayed) **= 15 weeks**

or

B-D-G-H = 14 weeks + 1 week (activity D-delayed) **= 15 weeks**

8. Probability of Project Completion. CPM aids the project manager to identify the expected project completion time of Milwaukee Paper Manufacturing which is 15 weeks. But, Joni Steinberg considers that for each time estimate variation occurs for each activity. This variation can affect the entire completion of the critical path which can possibly the cause of the delay of the project.

The University of Mindanao

8.1 The method below was used to calculate the variance per task completion period:

Variance = $[(b - a)/6]^2$

Variances for Milwaukee Paper's Project per activity

ACTIVITY	OPTIMISTIC *a*	MOST LIKELY *m*	PESSIMISTIC *b*	EXPECTED TIME $t = (a + 4m + b)/6$	VARIANCE $[(b - a)/6]^2$
A	1	2	3	2	.11
B	2	3	4	3	.11
C	1	2	3	2	.11
D	2	4	6	4	.44
E	1	4	7	4	1.00
F	1	2	9	3	1.78
G	3	4	11	5	1.78
H	1	2	3	2	.11

ote: Can you understand that there's more variance than in others? Notice how the optimistic and pessimistic period stretches.

8.2 PERT takes note of the variance in critical path activities to better assess the total project variation. The **project variance** is determined by summing up variances of critical activities along the critical path (see A-C-E-G-H).

σ_p^2 = Project variance

= $\sum$(variances of activities on critical path)

Thus referring to the critical activities:

Project variance = 0.11 (A) + 0.11 (C) + 1.00 (E) + 1.78 (G) + 0.11 (H) = **3.11**

Then compute for Project standard Deviation using the formula below:

Project standard deviation

$\sigma_p = \sqrt{\text{Project variance}}$

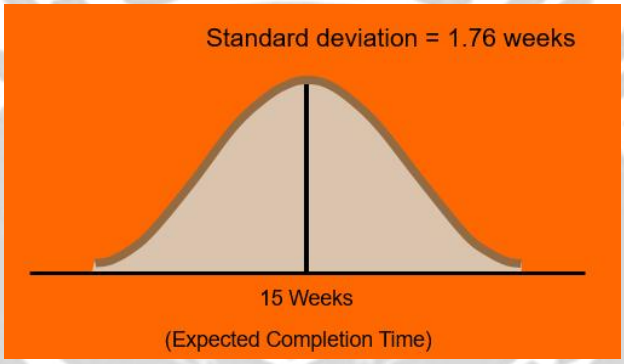
$= \sqrt{3.11} = 1.76$ weeks

Management also has an estimation not only of the project's projected completion time but also of the standard deviation from that forecast.

8.3 PERT sets forth two more assumptions:

- Maximum delivery periods for the project meet standard distribution of probability; and
- The periods of operation are statistically independent.

Using such premises, the usual bell-shaped curve shown below can be used to reflect dates of completion of a project. This normal curve indicates a 50 percent probability that the delivery period of the manufacturer's project would be less than 15 weeks, and a 50 percent risk that it will reach 15 weeks.



8.4 This is an opportunity to study your statistical skills and using a standard distribution table This is an opportunity to evaluate your statistical skills and use a normal distribution table (Appendix 1: Normal Curve Areas of the book of Heizer and Render, 2011)

Joni Steinberg would like to find out the possibility that her proposal would be finished on or before the EPA 16-week deadline.

APPROACH ► To do so, she needs to determine the appropriate area under the normal curve. This is the area to the left of the 16th week.

SOLUTION ►

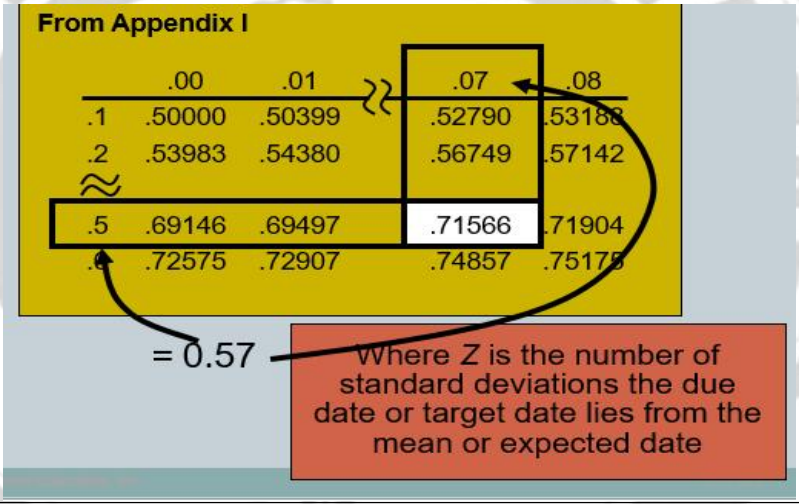
$$Z = \left(\begin{matrix}\text{Due}\\ \text{date}\end{matrix} - \begin{matrix}\text{Expected date}\\ \text{of completion}\end{matrix}\right)/\sigma_p$$

$$= (16 \text{ weeks} - 15 \text{ weeks})/1.76$$

$$= 0.57$$

Where Z is the number of standard deviations, the targeted date or value shall be the mean or anticipated value

In the Normal Table in Appendix 1, the Z value of 0.57 to the right of the mean shows a chance of 0.7157. Therefore, as seen below, there is a 71.57 percent likelihood that the pollution control equipment will be placed in operation in 16 weeks or less.



8.5 What Project Management Has Provided So Far:

- The project's completion time (expected) is 15 weeks;
- The computed percentage or chances to complete the project is 71.57%;
- The following are the activities under critical path (A, C, E, G, and H); and
- Non-critical activities includes activities B, D, F.

8.6 Project closing is concerned with formally ending a project. This contains final touches of the entire work, termination of contracts, bills payment, discussion and turnover of the finished project to the client/owner, and reassignment of the personnel and equipment used in the entire project. It is vital to end the project with proper documentation because this can be used as guide of the future similar project. Usual project closing ended in the ribbon cutting activity which also signify the start of usage of the project

output by its owner/client. Managing project is demanding and needs passion, it also needs large amount of investment and meticulous choose of talents and quality inputs to fight challenges.

9. **Cost–Time Trade-Offs and Project Crashing.** Usually, several challenges will be encountered in project management:
   - Projects are behind schedule; and
   - The deadline for delivery is pushed on

9.1 Either situation requires the project manager to fast track the remaining activities by the new desired deadline. Cutting the date of completion is called **project crashing.**

9.2 Project crashing. Shortening the network of operation to reduce the period on the critical path, thereby decreasing overall completion time. In project crashing, identifying the cheapest activity to be shortened is the wisest thing to do.

9.3 Factors to Consider When Crashing a Project. There are some factors that needs to be considered when crashing a project and these are:
- The cheapest amount of an activity to be crashed shall be considered;
- Total Crash time should be monitored; and
- The total cost of crashing should be as small as possible.

9.4 Steps in Project Crashing. Crashing a project involves these steps:

1. Compute the crash cost per time period. If crash costs are linear over time:

$$\text{Crash cost per period} = \frac{(\text{Crash cost} - \text{Normal cost})}{(\text{Normal time} - \text{Crash time})}$$

CPM is a method that has a normal or typical duration for any operation that we use in our computations. The average expense of the operation is correlated with the particular duration. Another time in project management, though, is the crash time, which is described as the shortest time frame possible to complete an operation. The crash cost of the operation is correlated with the crash time. We will typically shorten an operation by introducing additional services (equipment, personnel etc.) to it. Therefore, it is reasonable for an activity's crash cost to be greater than its usual cost. The consequence for the Overall Crash Period (the time required to shorten a project) and the Crash Cost per week of Milwaukee Paper Manufacturing is seen in the next figure:

2. Using current activity times, find the critical path and identify the critical activities

3. If there is only one critical path, then choose the activity that (a) may still crash on this critical path, and (b) have the lowest crash cost per period. This activity shall be crashed for one period.

   When there is more than one critical path, then choose one activity from each critical path such that (a) each chosen activity will always crash and (b) the smallest of all selected activities is the overall crash cost per period. Each operation crashes by one period. Notice that there could be more than one critical path common to the same activity.
4. Update all activity times. If her desired due dates has been reached, stop. If not, return to Step 2.

PROBLEM► Suppose Milwaukee Paper Manufacturing was only granted 13 weeks (rather than 16 weeks) to build the latest pollution control equipment or risk a court-ordered closure. If you know, the critical path for Joni Steinberg was 15 weeks long, but she still needs to finish the project in 13 weeks ' time.

APPROACH► To reach this due date of 13 weeks Steinberg has to decide which activities to crash, and by how much. Steinberg is obviously involved in speeding up the project by 2 weeks, at least at an added expense.

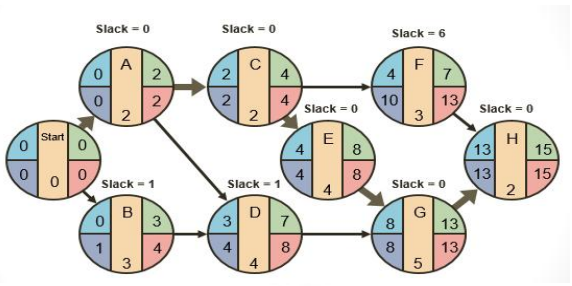
SOLUTION► The normal and crash times of the company, and the normal and crash costs, is displayed in the following table. Remember, for example, that the average period of operation B is 3 weeks (the approximation used in the critical path calculation), and its crash time is 1 week. It implies activity B will be reduced for up to two weeks if extra services are made available. The expense of these additional services is $4,000 (= difference between the cost of crashing and the normal cost). If we conclude that the crash cost is constant over time (the cost is the same per week), the crash cost of Activity B is $2,000 a week (= $4,000/2).

Normal and Crash Data for Milwaukee Paper Manufacturing

ACTIVITY	TIME (WEEKS) NORMAL	TIME (WEEKS) CRASH	Total Crash Time	COST ($) NORMAL	COST ($) CRASH	CRASH COST PER WEEK ($)	CRITICAL PATH ?
A	2	1	1	22,000	22,750	750	Yes
B	3	1	2	30,000	34,000	2,000	No
C	2	1	1	26,000	27,000	1,000	Yes
D	4	3	1	48,000	49,000	1,000	No
E	4	2	2	56,000	58,000	1,000	Yes
F	3	2	1	30,000	30,500	500	No
G	5	2	3	80,000	84,500	1,500	Yes
H	2	1	1	16,000	19,000	3,000	Yes

Step 2, 3, and 4 can now be applied to reduce Milwaukee Paper's project completion time at a

minimum cost.



The current critical path (using normal times) is Start A-C-E-G-H, where Start is just a dummy activity beginning from. Activity A has the lowest crash cost per week of $750, among such critical activities. Therefore, Joni Steinberg will crash activity A by 1 week to minimize the delivery period of the project to 14 weeks. The cost is an additional 750$. Note the Activity A can no longer be crashed further since it reached is crash limit to 1 week.

The original Start A-C-E-G-H path at this point remains critical, with a completion period of 14 weeks. However, with a completion period of 14 weeks, a new path Start B-D-G-H is critical now too. On all critical paths, however, further crashing must be achieved.

We need to identify one activity on each of these critical pathways which could still be crashed. We do would like to crash the least of the overall cost of crashing an activity on any path. We may be tempted to simply pick the activities with the lowest crash cost per cycle for each path. When we do so we should pick activity C from path one and activity D from path two. Therefore, the overall risk of the crash will be $2000 (= $1,000+$1,000).

But we spot activity G being common to both paths. This is, we'll concurrently raising the completion period of all paths by crashing activity G. While the $1,500 crash risk for activity G is greater than that for operation C and D; we will also choose to crash G, because the overall expense of crashing would still be just $1500 (compared to $2,000 if we crash C and D).

INSIGHT► Steinberg would crash activity A by 1 week, and activity G by 1 week to crash the project to 13 weeks. The net total expense is $2,250 (= $750 + $1,500). It is significant, as often project contracts provide incentives or fines for early or late completion.

9.5 Advantages of PERT/CPM:

- Helps in assessing complex projects;
- Just uses basic mathematical operation;
- Easy to understand due to illustration of graphical networks;
- Performing critical path and calculating slack time can help identify activities to focus on;
- The details of the project and the illustrations show who is responsible for the specific activities;
- Applicable for a wide variety of projects; and
- Effective for tracking not only plans but also prices.

9.6 Limitations of PERT/CPM:

- WBS formulation must be specifically identified and carefully analyzed to check interdependencies of relationship for each activity;

- Precedence relationships must be specified and networked together;
- Experts may over or under estimate expected time of completion per activity;
- There is an inherent danger of too much; and
- Emphasis being placed on the longest, or critical, path.

Self-Help: You can also refer to the sources below to help you further understand the lesson:

* Heizer, J. and Render, B. (2011). *Principles of Operations management*. 10th edition. Upper Saddle River, NJ: Prentice Hall, pp 95-114.

* Schroeder, R. G., Goldstein, S. M. and Rungtusanatham, M. J. (2017). *Operations management in the supply chain: decisions and cases.* 7TH edition. New York, NY: McGraw-Hill Education, pp 263-285.

Let's Check

Now that you rationalize the concept of PERT and CPM, let's try these simple exercises.

ASSIGNMENT EXERCISE 4. Create two AON networks based on the two given problem (17 points):

Activity	Description	Immediate Predecessor
A	Mark Utilities	-
B	Buy Trees	A
C	Dig Holes	A
D	Buy Flowers	A
E	Plant Trees	B,C
F	Buy Edging	B
G	Plant Flowers	D,E
H	Install Edging	F,G

Activity	Description	Immediate Predecessor
A	Design System	-
B	Write Program	A
C	Test Program	B
D	Write Documentation	A
E	Install System	C,D

Answer:

No. 1
No. 2

ASSIGNMENT EXERCISE. 5 Create an AON network and perform forward pass and backward pass. Answer the Questions below:

The University of Mindanao

Activity	Description	Immediate Predecessor	Time (in minutes)
A	Mark Utilities	-	10
B	Buy Trees	A	20
C	Dig Holes	A	30
D	Buy Flowers	A	20
E	Plant Trees	B,C	45
F	Buy Edging	B	20
G	Plant Flowers	D,E	30
H	Install Edging	F,G	40

Answer:

Questions:

a. What is the Project completion minutes? _____

b. Identify the critical activities: _____

c. Identify the non-critical activities: _____

d. Identify the critical path: _____

Let's Analyze

QUIZ EXERCISE 5. Let us raise the bar by answering the given problem below: 41 points

To complete the POS system for a certain cooperative, Elijah Mikaelson has laid out the 5 major activities involved. These activities have been labelled A through E in table below, which also shows their estimated completion time (in weeks), Immediate predecessor, and Cost estimates.

Requirements:

A. Compute for the Expected time (*t*) for each activity (round off to whole number); 5 points
B. Draw an AON diagram, solve for the forward/backward pass, and slack time; 7 points
C. Identify all the path and its corresponding time of completion per path; 4 points
D. Solve for the crash cost per week; 5 points
E. Crash the project into the most least weeks the project can be completed and calculate the total crash cost incurred in project crashing; 20 points

Activity	Description	Immediate Predecessor	a	m	b	Crash Time	Normal Cost	Crash Cost
A	Design System	-	2	3	5	2	Php 22,000	Php 22,400
B	Write program	A	3	4	5	2	23,000	23,500
C	Test Program	B	1	2	3	1	21,000	21,300
D	Write Documentation	A	1	2	3	1	22,000	22,600
E	Install System	C,D	2	3	4	2	28,900	29,000

Answer:

The University of Mindanao

In a Nutshell

Now that you understand the workings of PERT and CPM, you are ready to master dealing with projects soon in your career. PERT and CPM is an essential knowledge to possess on being an effective project manager. In this unit, you will be required to state your arguments or synthesis relevant to the topics presented. I will supply the first two items and you will continue the rest.

1. In crashing project, you must be wise to choose the activity with the least additional cost that can be incurred. Always be mindful with the total crash time and as to what path you'll have to crash (must be in critical path).
2. When to stop crashing? If there is no activity left to crash in at least one critical path because continuing will not anymore lessen the time of completion.

The University of Mindanao

Your Turn

3. _____

_____

_____

_____

4. _____

_____

_____

Q&A LIST.

In this section, students may list down all emerging questions or issues to help you in your review of concepts and essential knowledge. Answers will be specifically discussed in the scheduled video conferencing.

Do you have any Questions or clarifications?	
Questions/Issues	**Answers**
1.	
2.	

KEYWORDS INDEX.

Program Evaluation Review Technique	*Critical Path Method*	*Probability of Completion*	*Project Completion*
Z-Table	*Activity-on-nodes*	*Activity-on-arrow*	*Dummy activity*
Expected Time of Completion	*Project Variance*	*Project Standard Deviation*	*Variances*
Slack	*Total Slack*	*Project Crashing*	*Crash Cost*
Normal Cost	*Crash Time*	*Normal Time*	*Optimistic Time*
Pessimistic Time	*Most Likely Time*	*Forward Pass*	*Backward Pass*
Earliest Start	*Earliest Finish*	*Latest Start*	*Latest Finish*