COURSE GUIDE

DES 222
TECHNOLOGY AND SOCIOECONOMIC DEVELOPMENT

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Introduction

Welcome to DES 222: Technology And Socio-Economic Development. DES 222: Technology And Socio-Economic Development is a two-credit and onesemester undergraduate course for Economics students. The course is made up of twelve units spread across fifteen lecture weeks. This course guide gives you an insight to how technology and socio-economic development interact in a broader way and how to study and make use of its analysis in economics. It guides you on how to achieve the course aims and objectives successfully by adhering to the suggested general guidelines. Answers to your tutor marked assignments (TMAs) are within the material.

Course Competencies

This course is basically on technology and socioeconomic development because as an aspiring economist, you should be able to apply and adopt new techniques to socioeconomic problems. The topics covered include: Role of technology and historical growth of major economies; nature of technology change and socio-economic implication; technology transfer, diffusion and adoption of new technologies.

Course Objectives

To achieve the aims of this course, there are different specific objectives which the course is out to achieve and they are set out for each unit. Each unit starts with some listed objectives and students are expected to read them before working through the unit. After completing each unit, students are to refer back to the stated objectives. The essence is to assist the students in accomplishing the tasks entailed in this course and help the students assess if they have done what was required from the unit. At the end of the course period, the students are expected to be able to:

- Explain some basic technology and socioeconomic development concepts
- Differentiate between growth and development.
- Illustrate the difference between developed and developing economies
- Understand the determinants of economic development
- Describe technology life cycle
- Trace the history of technology evolution through industrial revolutions
- Give a brief history of technology development in Nigeria
- Understand the socioeconomic implications of technological change in developing countries
- Explain the process of technological change in developing countries

- Understand the issue of diversity in the choice of appropriate technology
- Explain the challenges of technology transfer especially in developing countries

Working Through this Course

To successfully complete this course, students are required to read the study units, the referenced books and other materials on the course. Each unit contains self-assessment exercises called Student Assessment Exercises (SAE), and in some cases will be required 6 to submit assignments for assessment purposes. At the end of the course there is a final examination. This course should take about 15weeks to complete and some components of the course are outlined under the course material subsection.

Study Units

There are 12 units in this course which needs to be studied diligently and carefully so as to achieve the set objectives.

Module 1 Role Of Technology And Historical Growth Of Major Economies

Unit 1 The Basic Concepts: Technology, Innovation and Socioeconomic Development
Unit 2 Economic Growth and Socioeconomic Development
Unit 3 Developed and Developing Economies
Unit 4 History of Technology in Industrial Revolution

Module 2 Nature Of Technological Change And Socioeconomic Implications

Unit 1 Technological Change and Technology Life Cycle.
Unit 2 Technological Change and Technical Progress.
Unit 3 Socioeconomic Implications of Technological Change.
Unit 4 Industrial Competition and Technology Change

Module 3 Technology Transfer, Diffusion And Adoption

Unit 1 Technology Transfer and Socioeconomic Development
Unit 2 Technology Diffusion and Adoption
Unit 3 Economic Theories of Technology Change
Unit 4 Issues of Technology Acquisition in Developing Countries.

Each study unit will take at least two hours, and it includes the introduction, objective, main content, self-assessment exercise, conclusion, summary and reference. Other areas border on the Tutor-Marked Assessment (TMA) questions. Some of the self-assessment exercise will necessitate discussion, brainstorming and argument with colleagues. Students 8 are strongly advised to do so in order to understand and get acquainted with the course and its objectives. There are also reference materials listed for further reading so as to get additional information. Study the materials; practice the self-assessment exercises and tutor-marked assignment (TMA) questions for greater and detailed understanding of the course. All these are necessary in order to achieve the stated aim and objectives

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Presentation Schedule

The presentation schedule included in the course materials gives the important dates for the completion of tutor-marking assignments and attending tutorials. Students are required to submit all assignments and before or on the due date. Kindly guide against falling behind in your work as this may affect your overall result.

Assessment

The course will be assessed using two formats: The tutor-marked assignments as well as a written examination. The assignments submit to your tutor for assessment will count for 30% of your total course mark

while the final written examination of three hours duration will count for the remaining 70% of your total course mark.

How to get the Most from the Course

In distance learning the study units replace the university lecturer. This is one of the great advantages of distance learning; you can read and work through specially designed study materials at your own pace and at a time and place that suit you best.

In the same way that a lecturer might send you some readings to do, the study units guides you on when to read your books or other materials. Think of it as reading the lecture instead of listening to a lecturer and embark on discussions with your colleagues. Similarly, just as a lecturer might give you an in-class exercise, your study units provides exercises for you to do at appropriate points.

Each of the study units follow a common format. The first item is an introduction to the subject matter of the unit and how a particular unit is integrated with the other units and the course as a whole. Next is a set of learning objectives. These objectives let you know what you should be able to do by the time you have completed the unit. Hence, use these objectives as a guide. When you have finished the unit you must go back and check whether you have achieved the objectives. If you make a habit of doing this you will improve your chances of passing the course and getting the best grades.

The main body of the unit guides you through the required reading from other sources. This will usually be either from your set books or from a reading section. Some units require you to undertake practical overview of historical events. You will be directed when you need to embark on discussion and guided through the tasks you must do.

The purpose of the practical overview of some certain historical economic issues are in twofold. First, it will enhance your understanding of the material in the unit. Second, it will give you practical experience and skills to evaluate economic arguments, and understand the roles of history in guiding current economic policies and debates outside your studies. In any event, most of the critical thinking skills you will develop during studying are applicable in normal working practice, so it is important that you encounter them during your studies.

Self-assessments are interspersed throughout the units, and answers are given at the end of the units. Working through these tests will help you to achieve the objectives of the unit and prepare you for the assignments and the examination. You should do each selfassessment exercises as you

come to it in the study unit. Also, ensure to master some major historical dates and events during the course of studying the material.

The following is a practical strategy for working through the course. If you run into any trouble, consult your tutor. Remember that your tutor's job is to help you. When you need help, don't hesitate to call and ask your tutor to provide it.

1. Read this Course Guide thoroughly.
2. Organize a study schedule. Refer to the `Course overview' for more details. Note the time you are expected to spend on each unit and how the assignments relate to the units. Important information, e.g. details of your tutorials, and the date of the first day of the semester is available from study centre. You need to gather together all this information in one place, such as your dairy or a wall calendar. Whatever method you choose to use, you should decide on and write in your own dates for working through each unit.
3. Once you have created your own study schedule, do everything you can to stick to it. The major reason that students fail is that they get behind with their course work. If you get into difficulties with your schedule, please let your tutor know before it is too late to help.
4. Turn to Unit 1 and read the introduction and the objectives for the unit.
5. Assemble the study materials. Information about what you need for a unit is given in the `Overview' at the beginning of each unit. You will also need both the study unit you are working on and one of your set books on your desk at the same time.
6. Work through the unit. The content of the unit itself has been arranged to provide a sequence for you to follow. As you work through the unit you will be instructed to read sections from your set books or other articles. Use the unit to guide your reading.
7. Up-to-date course information will be continuously delivered to you at the study centre.
8. Work before the relevant due date (about 4 weeks before due dates), get the Assignment File for the next required assignment. Keep in mind that you will learn a lot by doing the assignments carefully. They have been designed to help you meet the objectives of the course and, therefore, will help you pass the exam. Submit all assignments no later than the due date.
9. Review the objectives for each study unit to confirm that you have achieved them. If you feel unsure about any of the objectives, review the study material or consult your tutor.
10. When you are confident that you have achieved a unit's objectives, you can then start on the next unit. Proceed unit by unit through the course and try to pace your study so that you keep yourself on schedule.

11. When you have submitted an assignment to your tutor for marking do not wait for it return `before starting on the next units. Keep to your schedule. When the assignment is returned, pay particular attention to your tutor's comments, both on the tutor-marked assignment form and also written on the assignment. Consult your tutor as soon as possible if you have any questions or problems.
12. After completing the last unit, review the course and prepare yourself for the final examination. Check that you have achieved the unit objectives (listed at the beginning of each unit) and the course objectives (listed in this Course Guide)

Online Facilitation

The course, Technology and Socio-Economic Development (DSS 222) exposes students to the historical growth of major economies and the role of technology in socioeconomic development. You will also be introduced to technology life cycle as well the explanation of economic growth and socioeconomic development; the differences between developed and developing economies. This course also gives an insight into the nature of technological change and socioeconomic implications of technological change. Thereafter you will stimulated to understanding the role of technological change in enhancing industrial competitiveness. Finally, it shall enlighten you about technology transfer, diffusion and adoption of new technologies in developing economies.

However, to gain a lot from the course please try to apply anything you learn in the course to term paper writing in other economics courses. We wish you success with the course and hope that you will find it fascinating and handy.

MAIN COURSE

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Module 1 Role Of Technology And Historical Growth Of Major Economies

Unit 1 The Basic Concepts: Technology, Innovation and Socioeconomic Development
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Unit 1 The Basic Concepts: Technology, Innovation And Socioeconomic Development

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1.1 Introduction

This unit provides an overview of diverse conceptualizations and terminologies that have been introduced to describe technology and how it evolves. First, technology is defined as the invention of both material and immaterial tools in order to solve real-world problems. It consists of both hardware and software (the knowledge required to produce and use technological hardware). Second, the essential feature of technology is outlined. Technologies change all the time both individually, and in their aggregate, in an effort of replacing older technologies by newer ones. The most essential terminology distinguishes between invention (discovery), innovation (first commercial application) and diffusion (widespread replication and growth) of technologies. In this unit, because new developments must be explored and adopted.

1.2 Learning Outcomes (LOs)

At the end of this unit, you should be able to:

- Explain the concept of technology
- Explain the phases of technology development
- Differentiate between technology and innovations

1.3 Main Content

1.3.1 Definition and Explanation of Technology

The term technology comes from two Greek words: *tehno* and *logos* (science). It is a science to the sum of knowledge about procedures and processes used in the manufacture of material production. Technology, in a layman's understanding consists of manufactured objects such as axes, arrowheads, and their modern equivalents for the purpose of either to enhance human capabilities or to aid humans to perform tasks they could not otherwise perform. But technology is more than that. It requires a larger system including hardware (such as machinery or a manufacturing plant), factor inputs (labor, energy, raw materials, capital), and software (know-how, human knowledge and skills). The latter, for which the French use the term technique, represents the disembodied nature of technology, its knowledge base. Thus, technology includes both what things are made and how things are made.

Technology simply means the invention of both material and immaterial tools in order to solve real-world problems. Technology is also the sum of techniques, skills, methods, and processes used in the production of goods or services or in the accomplishment of objectives, such as scientific investigation especially in industry. Little wonder why technology replaces human workers with mechanical or electronic devices. An example is in the case ATM (Automated Teller Machine) in the banking industry. Finally, it makes use of fewer resources to manufacture goods more efficiently.

Technology concerns itself with understanding how knowledge is creatively applied to organized tasks involving people and machines that meet sustainable goals (Lane 2016).

Three things to learn from this definition are:

1. Technology is about taking action to meet a human need rather than merely understanding the workings of the natural world, which is the goal of science. An example is the invention of Microscope.
2. It goes beyond the use of scientist knowledge to include both values as much as facts, practical craft knowledge and the practical knowledge. The invention of iPod is an example of a small device accommodating much music with creative design.
3. It covers the intended and unintended interactions between products (machines, devices, artifacts) and the people and systems that make them, use them or are affected by them through various processes.

Technology is a hands-on thing and it involves skills like engineering, communicating, designing, developing, innovating, managing, manufacturing, modeling and systems thinking. It also has its proms and corns.

SELF ASSESMENT EXERCISE 1

i. Explain what you understand by technology

1.3.2 Characteristics of Technology Evolution

Technological evolution is neither simple nor linear. Its four most important distinctive characteristics are uncertain, dynamic, systemic, and cumulative.

i. First, technological uncertainty derives from the fact that there always exists a variety of solutions to perform a particular task. It is always uncertain which might be best, taking into account technical, social and economic criteria. Technological uncertainty prevails in all stages of technological evolution right from initial design, through success or failure in the marketplace, to eventual environmental impacts and spin-off effects. Since uncertainty will always persist, the correct strategy to forecast technological change is to also experiment with technological variety.
ii. Secondly, technology is dynamic and keeps changing all the time. Change includes a continuous introduction of new varieties and continuous subsequent improvements and modifications. The main factors governing technology dynamics are, first, the continuous replacement of capital stock as it ages and economies expand and, second and most important, new inventions.

iii. Third, technological evolution is systemic and cannot be treated separately. A new technology needs not only to be invented and designed, but it needs to be produced with other technologies. It also requires infrastructures. For instance, a telephone needs a telephone network; a car needs a road network. This interdependence of technologies causes enormous difficulties in implementing large-scale changes. Though this is what causes technological changes to have such persistent and extensive impacts once they are implemented. These mutually interdependent and cross-enhancing sociotechnical systems of production and use cannot be considered in terms of single technologies, but must be considered in terms of the mutual interactions among all contemporary technological, institutional, and social change.

iv. Fourth, technological change is cumulative based on knowledge and previous experiences. Only in rare cases is knowledge lost and not reproducible. A new artifact, like a new species, is seldom designed from the scratch. Hence, technological knowledge and the stock of technologies in use grow continuously.

SELF ASSESMENT EXERCISE 2

Discuss the at least 3 characteristics of technology evolution.

1.4 Phases in Technology Development

Joseph A. Schumpeter an Austrian economist distinguished three important phases in technology development: invention, innovation, and diffusion.

- ***Invention*** **-** is the first demonstration of the principal, physical feasibility of a proposed new solution. An invention is usually related to some scientific discovery, frequently measured through patent applications and statistics. However, an invention by itself often offers no hints about possible applications despite the technological nostalgia surrounding the inventor's human ingenuity. Even where applications are apparent, an invention by itself has no economic or social significance whatsoever.

- ***Innovation*** **-** is defined is the point when a newly discovered material or a newly developed technique is being put into regular production for the first time, or when an organized market for the new product is first created. A distinction is frequently made between process and product innovations. Process innovation refers to new methods of production, while the product innovation refers to directly usable technological hardware, for instance, consumer products such as video recorders and compact disc

players. It is an essential feature of the evolutionary character of technological change. Innovation is the implementation of creative ideas in order to generate value, usually through increased revenues, reduced costs or both. Innovation involves executing an idea which address a specific challenge and achieves value for both the company and the customer alike.

- ***Diffusion*** - is the widespread replication of a technology and its assimilation in a socioeconomic setting. Diffusion is the final, and sometimes painful, test of whether an innovation can create a niche of its own or successfully supplant existing practices and artifacts. Technology assumes significance only through its application (innovation) and subsequent widespread replication (diffusion). Otherwise it remains either knowledge that is never applied, i.e., an invention without subsequent innovation, or an isolated technological curiosity, i.e., an innovation without subsequent diffusion.

Types of Innovation

I. **Incremental Innovation**: Incremental Innovation is the most common form of innovation. It utilizes your existing technology and increases value to the customer (features, design changes, etc.) within your existing market. Almost all companies engage in incremental innovation in one form or another.

II. **Disruptive Innovation**: Disruptive innovation, also known as stealth innovation, involves applying new technology or processes to your company's current market. It is stealthy in nature since newer technology will often be inferior to existing market technology. This newer technology is often more expensive, has fewer features, harder to use, and is not as artfully pleasing. It is only after a few iterations that the newer technology surpasses the old and disrupts all existing companies. By then, it might be too late for the established companies to quickly compete with the newer technology.

III. Architectural Innovation: Architectural innovation is simply taking the lessons, skills and overall technology and applying them within a different market. This innovation is amazing at increasing new customers as long as the new market is receptive. Most of the time, the risk involved in architectural innovation is low due to the reliance and reintroduction of proven technology. Though most of the time it requires some adjustments to match the requirements of the new market.

IV. Radical Innovation: This gives birth to new industries (or swallows existing ones) and it involves creating revolutionary technology. The airplane, for example, was not the first mode of

transportation, but it is revolutionary as it allowed commercialized air travel to develop and prosper.

1.5 Differences between technology and innovation

Technology is the application of scientific knowledge (things known) for the purpose of practical application in industry. Technology involves the development of devices and machines from scientific knowledge already available. It involves a lot of different techniques that help to reduce efforts for example washing machines, smart phones, etc. Technology is something to which we adopt for our betterment and allows people to do different things at the same time. Current technology is the product of yesteryears innovation which has made life easier for the people.

Innovation mean means being creative or inventive in solving a problem. This means the creation of new things, new methods, products, ideas or new ways of doing things which was not known earlier on. Innovation is something unique, new that has never been created or produced and will be released in the future so as to help to reduce workload for the people.

SELF ASSESMENT EXERCISE 3

i.	Identify the different phases of technology development
ii.	Explain the following concepts: (a) Innovation (b) Invention
iii.	Differentiate technology from innovation.

1.6 Summary

Technology is simply the way we do things as well as the means through which we accomplish objectives. Innovation is something new such as new ideas, new methods, products, etc. Technology and innovation should not be used interchangeably because technology is an outcome of innovation of yesteryears. Innovation is a great idea, executed brilliantly, and communicated in a way that is both intuitive and fully celebrates the magic of the initial concept. Innovations create bigger opportunities and are critical for the survival, economic growth, and success of a company. In this unit, we have discussed on the concept of technology and innovation. The term technology comes from techno and logos. It covers the sum of knowledge about procedures and processes not only in manufacturing but also in other spheres of social life and, secondly, includes the procedures and processes. The unit also discussed types of innovation such as incremental innovation, disruptive, architectural and radical innovation.

The unit also discussed the phases of technology development.

1.7 References/Further Readings

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1.8 Possible Answers to SAEs

Answers to SAEs 1

1. Technology simply means the invention of both material and immaterial tools in order to solve real-world problems.

Answers to SAEs 2

- First, technological uncertainty derives from the fact that there always exists a variety of solutions to perform a particular task.

- Secondly, technology is dynamic and keeps changing all the time.

- Third, technological evolution is systemic and cannot be treated separately.

Answers to SAEs 3

1. • Invention: An invention is usually related to some scientific discovery, frequently measured through patent applications and statistics.
- Innovation - is defined is the point when a newly discovered material or a newly developed technique is being put into regular production for the first time, or when an organized market for the new product is first created.
- Diffusion -. Diffusion is the final, and sometimes painful, test of whether an innovation can create a niche of its own or successfully supplant existing practices and artifacts.

2. Innovation is something new such as new ideas, new methods, products, while Invention - is the principal, physical feasibility of a proposed new solution.
3. Technology involves the development of devices and machines from scientific knowledge already available. While Innovation is something unique, new that has never been created or produced and will be released in the future so as to help to reduce workload for the people.

Unit 2 Economic Growth And Socioeconomic Development

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2.8 Possible Answers to SAEs

2.1 Introduction

Economic growth is the sustainable increase in the total amount of the goods and services (output) produced in an economy over time. Most times, economic growth is used as a means of knowing how well a country is doing because more output means more trade, more revenue and more consumption. It is an indication of how big an economy is growing, but this does not show how better it is getting, hence development has been used as a better measure. Socio-economic development is a sustainable increase in the total or average outputs of all goods and services produced in a country, accompanied by desirable social and institutional changes. This is to say that development is growth accompanied by certain desirable changes. For any economy to develop, it has to experience sustainable growth which is a necessary but not a sufficient condition. The desirable changes which lead to the overall improvement in the living conditions of the citizens in a country are numerous and they are the reasons why we can have growth without development. In this unit, we examine the concept of economic growth and socio-economic development.

2.2 Learning Outcomes (LOs)

At the end of this unit, you will learn how to:

- Define the concept of economic growth
- Describe how economic growth is measured
- State the advantages and disadvantages of economic growth.
- Explain the components of socioeconomic development
- Differentiate between economic growth and socioeconomic development.

2.3 Main Content

2.3.1 What is Economic Growth?

The term economic growth has been variously defined. To an economist, economic growth is a sustained increase in the national income (NI) or the total output of all goods and services produced in an economy. It is an increase in the capacity of an economy to produce goods and services, compared from one period of time to another. Economic growth according to Todaro and Smith (2012) is the steady process by which the productive capacity of the economy is increased over time to bring about rising levels of national output and income.

Economic growth is a long-term rise in the capacity to supply increasingly diverse economic goods to its population, this growing capacity based on advancing technology and the institutional and ideological adjustments that it demands. This means that for an economy to achieve growth there should be advancement in technology accompanied by institutional and attitudinal adjustments.

Economic growth occurs whenever people take resources and efficiently rearrange them in ways that make them more productive overtime. It is the continuous improvement in the capacity to satisfy the demand for goods and services, resulting from increased production scale, and improved productivity i.e. innovations in products and processes.

In summary, economic growth is an increase in the capacity of an economy to produce goods and services, compared from one period of time to another. It can be measured in nominal or real terms, the latter of which is adjusted for inflation. Traditionally, aggregate economic growth is measured in terms of gross national Product (GNP) or gross domestic product (GDP), although alternative metrics are sometimes used.

Economic growth is an important macroeconomic goal because it means there is more material abundance brought about by efficient management of scarce resources. Growth therefore lessens the burden of scarcity in any economy. The study of economic growth provides learners with both theoretical and empirical understanding of how different factors combine together to provide the right framework for a country's long run growth. The study economic growth helps us to know how to use existing resources efficiently (by avoiding costly waste) and invest in new ones. Economic growth provides a necessary, although not sufficient condition for the development of an economy - without growth, there will be no development. Therefore, the study of growth is important to understand how a country can achieve development. Since economic growth is largely about innovation, which is also the key to non-material progress in such areas as the environment, health, and education, economic growth is not just studied for the sake of output increase, but for a general progress in the economy.

SELF ASSESMENT EXERCISE 1

i. What do you understand by economic growth?
ii. Why is the study of economic growth important to an economy?

2.3.2 Measurement of Economic Growth

How do we know whether an economy is growing or not? The basic thing to do is to get the sum total of all the goods and services produced within the economy in the current year and compare it with that of the previous year.

The next question will then be - how can these products be summed up given the fact that they come in different weights and dimensions? The solution to this is to sum up based either on their market prices in the same currency or an indexing system which uses percentage changes in physical outputs of the goods and services relative to a given base year. In measuring economic growth, the most common method used is the Gross Domestic

Product (GDP) or its related indicators, such as Gross National Product (GNP) or Gross National Income (GNI) which are derived from the GDP calculation. The GDP is defined as the market value of the goods and services produced by a country, and it is calculated from a country's national accounts which state annual data on incomes, expenditure and investment for each sector of the economy.

There are three different ways of measuring GDP. They are: the income approach; the value-added approach and the expenditure approach.

The ***income approach*** as the name implies measures people's incomes, ***the value-added approach*** measures the total value added to the goods and services at each step of production, and the ***expenditure approach*** measures the expenditure on goods and services.

In theory, each of these approaches should lead to the same result, so if the output of the economy increases, incomes and expenditures should increase by the same amount. The problem here however, is that when using market prices to calculate GDP, inflation rates should be considered especially for those countries that have high and persistence inflation rates like the less developed countries.

2.3.3 Limitations of the Use of GDP to Measure Economic Growth

Despite the fact that the GDP is the most widely used means of measuring economic growth, it has the following limitations:

1. Some cash transactions that take place outside of recorded market places are not included in GDP statistics and as such the actual value of growth cannot be ascertained.
2. Goods and services produced but not exchanged for money, known as "nonmarket production", are not measured, even though they have value. For example, if you paint your house by yourself, instead of allowing a professional to paint it, the value of this service will not be included in GDP.
3. In calculating the real GDP, the GDP deflator is used and since the GDP deflator is based on estimates of inflation rates, it will be subject to statistical estimation errors.
4. The measure fails to take into consideration the changes in the growth of population. If a rise in real growth rate is accompanied by a much faster rise in population growth, then the per capita GDP (GDP divided by the number of people in the country) would be very low and as such there will be no economic growth.

2.3.4 Advantages and Disadvantages of Economic Growth

Advantages of Economic Growth

1. Higher living standards - since growth means a sustainable increase in the total output of goods and services produced in a country, consumers are able to enjoy more goods and services, increased income and a general improvement in living standard.
2. Employment effects - growth stimulates more jobs in an economy and this would address the issue of unemployment.

3. Lower government borrowing - economic growth boosts tax revenues and provides the government with extra money to improve public services such as education and healthcare. It helps to reduce government borrowing and makes it easier for a government to reduce the size of their budget deficit.
4. Environmental protection - growth can also help provide the funds to protect the environment such as low-carbon investment, innovation/research and development, in the use of more efficient and environmental friendly production processes. Countries with higher growth rates can afford the luxury of protecting the environment.

Disadvantages of Economic Growth

1. Working hours – sometimes there are fears that a fast-growing economy places increasing demands on the hours that people work and can upset work-life balance.
2. Environmental issues - a fast growing economy can put pressure on the environment in terms of depletion of the non-renewable natural resources, and damage caused by industrial/economic activities on the environment e.g. air, water and noise pollutions.
3. Inequality- not all of the benefits of economic growth are evenly distributed. There could be a rise in national output but also growing income and wealth inequality in the society.
   There could also be regional differences in the distribution of rising Income and spending.
4. Risk of inflation - if the economy grows too quickly, there is the danger of inflation as spending would likely grow faster than production. This means that the demand races ahead of the ability of the economy to supply goods and services. Producers then take advantage of this by raising prices of their goods and services.

SELF ASSESMENT EXERCISE 2

i. List and explain the different methods of measuring economic growth.

ii. Discus why it is important to measure the growth of a nation.

2.4 What is Socioeconomic Development?

Socioeconomic development is made up of two words relating to social factors like education and profession as well as economic factors such as income and resources. Socioeconomic development is defined as the process of change or improvements in social and economic conditions as they relate to individuals, organization or society as a whole. It is

measured with indicators, such as GDP, life expectancy, literacy and levels of employment. Changes in less-tangible factors are also considered, such as personal dignity, freedom of association, personal safety and freedom from fear of physical harm, and the extent of participation in civil society. Causes of socioeconomic impacts are, for example, new technologies, changes in laws, changes in the physical environment and ecological changes.

2.4.1 The Objectives of Development

Development in all societies must have at least the following three objectives:

1. To increase the availability and widen the distribution of basic life-sustaining goods such as food, shelter, and protection.
2. To raise level of living standard. This involves in addition to higher income, the provision of more jobs, better education, and greater attention to cultural and human values, all of which will serve not only to enhance material well-being but also to generate greater individual and national self-esteem.
3. To expand the range of economic and social choices available to individuals and nations by freeing them from servitude and the dependence not only in relation to other people and nation-states but also to the forces of ignorance and human misery.

SELF ASSESMENT EXERCISE 3

i. Define socioeconomic development.

ii. What are the basic objectives of economic development?

2.4.2 Components of Socioeconomic Development

Socioeconomic development of any region or area depends on many factors or components. Some of these components include:

i. Per Capita Income - Per capita income is widely accepted as a general measure of development. It is customary to identify whether a region has been backward or advanced in the levels of development using the estimates of per capita income. The regions which enjoy higher per capita income are deemed to be more developed than the states or regions with low per capita income. Generally per capita income has been taken at current price. This variable or component is commonly used for measuring economic development. Under-developed economies are distinguished from the developed economies on the basis of their low per capita income.

ii. **Level of Agricultural Development -** Agricultural development is a pre-requisite of economic growth in our country. Agriculture is important not only to meet the ever growing and ever pressing demand for food and fibers for human consumption but also for providing forage for animals, raw materials for non-agricultural sector, employment opportunities to rural population and improves their standard of living. Agriculture is the mainstay of almost all the states of the nation. According to an UNESCO group of experts, agriculture can contribute to growth by increasing efficiency of popular and releasing resources to other sector by adjusting the consumption and of agricultural production in proportion with the growth in internal and external demands.

iii. **Level of Industrial Development -** Industrialization is a key force of rapid development of any economy. Most of the economists have accepted industrialization as the most pre-dominant component of their development strategies. Industrial units of organize sectors generally provide life blood to the economic system by their leading role in transmitting growth impulses to the surrounding area through their backward and forward linkages. Most of the infrastructure facilities such as, means of transportation and communication, power and banking expand along with industrial development, while, their availability in the area causes concentration of industries. Industrialization not only provides employment opportunities and reduces the dependence of workforce on agriculture but also acts as an agent of socio-cultural transformation by bringing about urbanization.

iv. **-** Urbanization means that an increasing proportion of human society become towns folk, and as this happen towns grow in population, spread in area, and make an ever increasing impact upon the countryside, both upon its appearance and upon the life of its inhabitants. More and more of the landscape becomes townscape and people come to live in an environment that is both physically and socially urban.

v. **Occupational Structure -** The occupational structure of a region is known with the distribution of its working population among different economic activities which are most significant aspect of an economy. Occupational structure of a society is one of the good indicators of social and economic inequality, because to a large extent it determines the level of living. Study intended to understand the pattern of disparity should, therefore, give due attention to this feature. In addition to providing an insight into the nature of economy it also throws light on socio-economic, cultural and political conditions of the society.

vi. **Levels of Educational Development -** Education is a crucial factor of social, economic and cultural development. It provides economic opportunities and helps to overcome social barriers. It

also enhances earning potential and productivity of people through acquisition of skill and information for various opportunities and jobs. Educational achievement not only in the stepping stone to job opportunities and hence earnings, but in the words of Horace Mann, education is beyond all other devices of human origin, a great equalizer of the conditions of men, the balance wheel of social machinery. Thus, the level of education determines the quality of people and development of a region.

vii. **Level of Health Status -** The term 'health' has been defined in different ways by scholars and organizations. In view of World Health Organisation (WHO), health is a state of complete physical and mental well-being and not merely the absence of disease or infirmity. It can also been seen as optimum capacity of an individual for effective performance of the role and task for which he has been socialized. Thus, health is a state of soundness of mind and body of an individual in which he is free from any sort of disorder. The ultimate aim of all economic policies is to achieve a healthy nation. A healthy nation can emerge only when there is adequate supply of proper balanced food, when people are not undernourished or malnourished. Poverty and health do not go together and hence in order to improve the health standard it is imperative to eliminate poverty.

viii. **Transport and Communication -** Transport and communication is an essential economic infrastructure for the rapid development of any region. In a planned economy, location of industries, development of backward areas, decentralization of economic activities, better distribution of products, better maintenance of law and order, justice, defense and security all necessitate a proper system of transport and communication. The modem concept of growth issues can meaningfully be implemented only if there is proper transport network within a region.

ix. **Population Structure -** Population structure included population growth, population density, age, sex, fertility, mortality etc. Population structure determines the nature and magnitude of demand pressure on resources as well as the quantity and quality of workforce to operate economic production mechanism. no regional and socio-economic development plan can afford to neglect them but at its own risk.

Population structure is having great subjective significance in the fields of Sociology, Demography and Economics. Presently, all governments irrespective of their socioeconomic and political ideologies are undertaking regional planning to optimize economic production and to minimize regional disparities in economic and social development. Population structure and development are closely interrelated, they both influences each other.

SELF ASSESMENT EXERCISE 4

i. Highlight the major determinants of socioeconomic development

2.5 Measurement of Economic Development

i). GNP and GNP per capita approach

These are termed income approaches because they aim at measuring productivity and incomes of people over a period of time. The GNP approach measures the real national income over a period of time. It considers the changes in a country's total output of final goods and services in real terms. The GNP per capita approach on the other hand is similar to GNP measurement only, it takes into consideration the population factor and therefore its measurement is based on what income an individual receives out of the entire available income.

ii). Welfare Measure

In this method of measurement, economic development is viewed as a process whereby there is an increase in the consumption of goods and services of individuals mainly as a result of increase in income. This measurement looks at the increase in consumption of individual in an economy but since consumption of goods and services is based on taste and preferences of individuals, how can the weight of these outputs be measured when preparing the welfare index of all the individuals? Again, it is not correct to say that with the increase in national income, the economic welfare of the people might have improved.

iii). Social Indicators

Due to the inability of the above measures to capture in totality, the "desirable change" aspect of development, some economists have tried to measure it in terms of social indicators. Social indicators are usually referred to as the basic needs for development, and these basic needs focus on alleviation of poverty by providing the basic human necessities to the poor. Examples of the basic needs are food, clothes, healthcare, education, water, sanitation and housing. The direct provision of these needs affects poverty in a faster and cheaper way than the above strategies. The basic advantage of the social indicators is that they are concerned with ends. Ends here are human development and the means to this end is economic development.

However, different basic needs have their different indicators, but the problem with these indicators is that there is no unanimity among economists as to the number and type of items to be included in measuring development and this is a major limitation of this method. For

example, Hicks and Streeten (1979), considered six social indicators for basic needs and they are:

1. Health as a basic need with life expectancy at birth as its indicator.
2. Education, as basic needs and indicator as the literacy taken as the primary school enrolment as a percentage of population
3. Food as basic need with calories supply per head as indicator.
4. Water supply as basic needs and infant mortality and percentage of population with access to portable water as the indicator.
5. Sanitation as a need and infant mortality and percentage of population with access to sanitation.
6. Housing

One limitation of the social indicators method is that they are concerned with current welfare and are not future related. Also, they involve value judgments. Therefore to avoid this problem of value judgment and also for simplicity sake, economists and UN organizations use GNP per capita as the measure of economic development.

SELF ASSESMENT EXERCISE 5

i. How do we measure socioeconomic development?

2.5.1 Economic Growth and Socioeconomic Development Compared

Economic growth and socio-economic development are sometimes wrongly used interchangeably. Below is a tabular representation of their differences.

Table 1. The Differences between Economic Growth and Socioeconomic Development

	Economic Growth	**Socioeconomic Development**
Definition	The sustained increase in the aggregate output or supply of goods and services produced in a country	Economic growth accompanied by desirable economic, social and institutional changes in an economy.
Applicability/ Relevance	Growth theories are associated with developed countries. Though widely used in all countries of the world. Economic growth is a more relevant measurement for progress in developed countries.	Socioeconomic development theories are specific to the developing countries because it is more relevant to measuring progress and quality of life in developing nations.
Effect	Quantitative: Brings about quantitative increase in the economy	Qualitative and Quantitative: Brings about qualitative and quantitative changes in the economy and society
Measurement	Increase in GDP per capita	Human Development Index (HDI) which is a composite statistics of the health, education, and income indices.

SELF ASSESMENT EXERCISE 6

i. Identify the differences between economic growth and socioeconomic development.

2.6 Summary

Economic growth as we stated at the beginning of this unit, is the increase in the total amount of the goods and services (output) produced in an economy over time. Economic growth brings about innovation, increases output, raises income, creates employment opportunity and when this growth is sustained, the standard of living of the people will improve. However, a rapid growth rate should be avoided because it could lead to several problem among which is inflation. The knowledge of the concept of growth is very important because it is through this knowledge that we are able to calculate the actual growth rate of an economy and then know the necessary steps policy makers can take to adjust growth rates to a desirable level.

In this unit, the concepts of economic growth and socioeconomic development were treated. From our discussions, we state clearly that though economic growth and development are most often used synonymously, they are quite different, with economic growth being a precondition for development. Socio-economic development is a multidimensional process that goes beyond economic growth and involves the entire social system. It is about the betterment of the human life and how this can be fulfilled and sustained.

2.7 References/Further Readings

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2.8 Possible Answers to SAEs

Answers to SAEs 1

1. To an economist, economic growth is a sustained increase in the national income (NI) or the total output of all goods and services produced in an economy.

- it means there is more material abundance brought about by efficient management of scarce resources.
- Growth therefore lessens the burden of scarcity in any economy.
- The study of economic growth provides learners with both theoretical and empirical understanding of how different factors combine together to provide the right framework for a country's long run growth.

Answers to SAEs 2

1. **The income approach** as the name implies measures people's incomes**, the value-added approach** measures the total value added to the goods and services at each step of production, and the **expenditure approach** measures the expenditure on goods and services.

2. without growth, there will be no development, so it is very important to measure growth in other to ascertain how the country can achieve development.

Answers to SAEs3

1. Socioeconomic development is defined as the process of change or improvements in social and economic conditions as they relate to individuals, organization or society as a whole.
2. To increase the availability and widen the distribution of basic life-sustaining goods such as food, shelter, and protection. To raise level of living standard.

Answers to SAEs4

1. Transport and Communication - Transport and communication is an essential economic infrastructure for the rapid development of any region.
2. Occupational Structure - The occupational structure of a region is known with the distribution of its working population among different economic activities which are most significant aspect of an economy.

Answers to SAEs 5

Answers to SAEs 6

1. Economic growth The sustained increase in the aggregate output or supply of goods and services produced in a country while Socioeconomic Development is Economic growth accompanied by desirable economic, social and institutional changes in an economy.

Unit 3 Developed And Developing Economies

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3.1 Introduction
3.2 Learning Outcomes (LOs)
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3.1 Introduction

Development is the process of improving the quality of all human lives and capabilities by raising people's levels of living, self-esteem, and freedom. The path to development entails how economies are transformed from stagnation to growth and from low income to highincome status, and overcome problems of absolute poverty. We shall discuss the characteristics of a developed economy and a developing economy to enable you understand issues around socioeconomic development.

3.2 Learning Outcomes (LOs)

At the end of this unit, it is expected that the students should be able to

- Define developed and developing economies
- Highlight the different characteristics of a developed economy and a developing economy
- Discus the determinants of socioeconomic development.

3.3 Main Content

3.3.1 Meaning and Characteristics of a Developed Economy

Development of a country is measured by its overall economic stability, industrial development, technological advancements, etc. A developed economy is defined as one with relatively high level of economic growth, improved standard of living, enhanced technological infrastructure and

security (Metu et al, 2017). A developed economy, also referred to as an industrialized country is characterized by low birth rate, higher life expectancy, high level of literacy and a well trained workforce.

An economy's level of development can be measured using the Human Development Index (HDI), and living standards of the general population.

Fig 1: A Sample Picture of a Developed Country (Hong Kong)
Source: www.insidermonkey.com

The characteristics of a developed economy are:
There are several parameters used to determine the level of economic development of a country and they include Human Development Index, income per capita, political stability, industrialization, freedom and living standards of the general population, Gross national

Product (GNP), and Gross Domestic Product (GDP). Therefore, a country that has performed so well in these areas referred to as developed country. The identified factors are discuss as follows:

i. **The Level of Human Development Index (HDI)**
HDI is a measure developed by the UN to measure human development in a country and the higher the HDI the more prosperous the country is. Unlike the GDP or GNP, which give income and productivity only, HDI give how income is turned into human development like education or health. For a developed country the literacy, education, and health levels are high. When considering HDI, access to good health care and child mortality rate at birth is considered while access to quality and free education, years spent in school and ability to incorporate learned knowledge to real-life situations are considered. In a developed nation, the rate of child mortality at birth is extremely low, and the education is

accessible to all. The HDI is always quantified and put on a scale between 0 and 1 with most developed having a score above 0.8.

ii. **The Level of Per Capita Income**

This refers to the average amount of money a person receives within one year in a specific region. It is calculated by dividing the total income in a specific country by the total population of that country, and this value is always high in a developed country. High per capita income signifies high economic and financial security for the general population of that nation. The Gross Domestic Product (GDP) is also used to determine the per capita value. GDP is the market value of the final product produced in a country for a particular period mostly quarterly or yearly. If the GDP of a nation is high, then that state is more developed.

iii. **High rate of industrialization**

For a developed country, the rate of industrialization and employment is high thus the general population depends less on agriculture. Such a nation will have higher export than imports hence the profits from the international trade will ensure that there is economic growth hence increase in industrialization. The technological infrastructure of a developed nation is also high due to the high level of industrialization.

iv. **Political Stability**

The index for measuring political stability was developed by World Bank and it is a measure of the level of development of a country. Developed countries have stable political environment, low or no corruption, and high level of respect to the country's laws. Good Governance ensures that the level of corruption is low, transparency in running the government is high, and employment is based on merit and qualifications. Recently The Global Governance Indicator, a standardized scale being used to measure the political stability of a developed nation.

v. **High standard of living**

The cost of living in a developed country is high compared to the less developed country, and this is because the majority of the population is willing and has the financial ability to afford quality goods and services which are expensive. Secondly, goods produced by local industries are mostly consumed as opposed to imported products which might be inferior. The general public has access to clean water and environment, affordable and quality housing and access to other social and economic amenities in the country like access to emergency services are fast.

vi. **Freedom and Respect for the Rule of Law**

A developed country has freedom for its citizens and respects the law. The freedom to worship, marry, own property, and access to information characterizes a developed nation. In the less developed countries, there

are a lot of restrictions and citizens cannot do whatever they like freely. Some of the developed countries are Australia, the United States of America, Canada, Japan, Germany, and United Kingdom among others. The other characteristic of a developed economy includes low income inequalities; low level of unemployment; high rate of saving and capital accumulation; advancement in technological adaptation; improved infrastructural facilities and they export largely industrial services and products

SELF ASSESMENT EXRECISE1

i. What do you understand by a developed economy?

ii. Outline the characteristics of a developed economy.

3.4 Meaning and Characteristics of a Developing Economy

Similarly, a developing economy (less developed economy) is an economy with an underdeveloped industrial base and a low human development index relative to other developed countries. In most developing economies, rapid population growth is always a threat to economic development. Some developing countries exhibit strong economic growth and dynamics, while other countries stagnate.

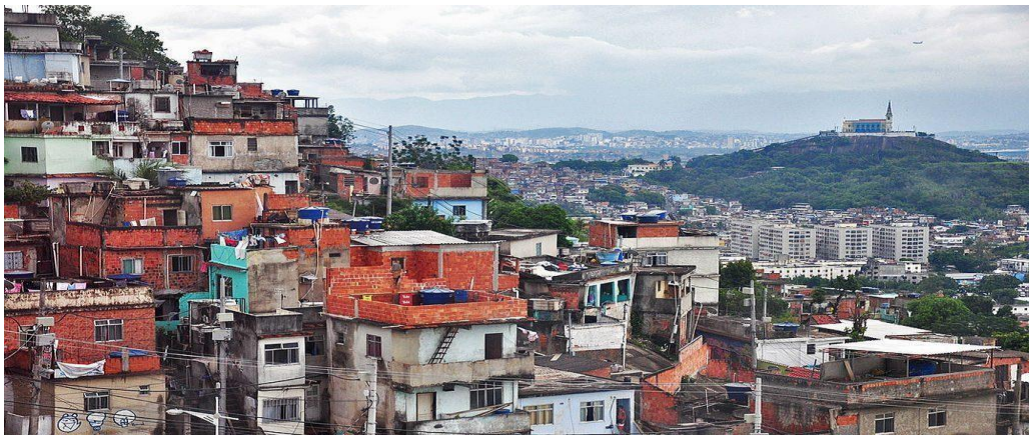

Fig 2: Picture of a Developing Economy (Nigeria)
Source: www.doc-research.org

The characteristics of a developing economy are:

i. **Low level of GNI per capita**: The Gross National Product (GNP) per capita or Gross National Income (GNI) per capita is often considered to be a good index of the economic welfare of the people in a country. The GNI per capita in developing countries is very low. This low level of GNI per capita is sufficient to reflect the plight of common people in these countries.

ii. **Larger income inequalities:** In developing countries apart from GNP per capita being considerably lower, income inequalities are also larger than in developed countries. Statistics from World Development Indicators overtime lends credence to the view that income inequalities are far greater in developing countries than in developed countries. According to Simon Kuznets, inequalities are much larger in developing countries than developed countries.

iii. **Widespread Poverty:** The extent of absolute poverty is an important dimension of the problem of income distribution in the developing countries. At relatively lower levels of GNP per capita, large income inequalities exist in the developing countries. This has also resulted in widespread poverty. China`s case lends confidence to the view that in near future if developing countries wish to wipe out poverty they have no choice but to improve the income distribution so as to ensure a minimum standard of living, clothing, sanitation, health, education and so on.

iv. **Low levels of Productivity:** Labour productivity in developing countries is invariably low. It is both a cause and effect of low levels of living in these countries.

Todaro and Smith affirm that "low levels of living and low productivity are selfreinforcing social and economic phenomena in third World countries and as such are the principal manifestations of and contributors to their underdevelopment". Labour productivity depends on a number of factors, particularly the availability of other inputs to be combined with labour, health and skill of workers, motivation for work and institutional flexibilities. Unfortunately, developing countries lack such inputs.

v. **Great dependence on agriculture with a backward industrial structure:** Harvey Leibenstein asserts that developing economies are basically agrarian in their character. In these countries agriculture and allied activities generally account for 30% to 80% of the labour force. This is true of most of the Asian and African countries. As compared to overall labour productivity, labour productivity in the agricultural sector is lower in the developing countries than in the developed countries. The industrial sector in the developing countries is both small and backward while the extended industrial sector in these countries accounts for about a fifth of the total product in these countries, less than 10% is allocable to manufacturing proper.

vi. **High levels of unemployment and underemployment:** Unemployment in both rural and urban areas is widespread in the developing countries. The traditional agriculture characterized by outmoded techniques of production and low level of productivity lacks labour absorption capacity. Thus, with rapidly growing population in these countries, pressure of population on

agricultural land has been increasing and with it the problem of disguised unemployment is becoming increasingly serious. In developing countries, markets for manufacturers are quite small due to widespread poverty. Faced with the problems of lack of adequate demand, industries grow at a snail pace and fail to provide jobs in sufficient number to absorb the growing population.

vii. **Technological Backwardness:** In developing countries, production techniques are inefficient over a wide range of industrial activity. This sorry state of affairs cannot be explained in terms of one or two factors. Lack of research and development (R&D), weak communication system between the research institutes and industries, abundance of labour and capital scarcity are some obvious reasons for the use of techniques which have otherwise become obsolete. Developing countries generally do not have large effective institutions necessary for the discovery of appropriate technology. Under this circumstance, an attempt is made to import technology from developed countries which often fail to adapt to local conditions.

3.5 Determinants of Economic Development

i. Human Development Index (HDI): The Human Development Index (HDI) measures achievements in three aspects of human development: health, education and living standards. Unlike the GDP or GNP, which give income and productivity only, HDI was introduced as an alternative to such conventional measures of economic development. With the imperfect nature of economic wealth as a gauge of human development, the HDI offers a powerful alternative to conventional measures for measuring well-being and socio-economic progress. For a developed country, the literacy, education, and health levels are high. When considering HDI, access to good health care and child mortality rate at birth is considered while access to quality and free education, years spent in school and ability to incorporate learned knowledge to real-life situations are considered. In a developed nation, the rate of child mortality at birth is extremely low, and the education is accessible to all.

ii. Income Per Capita: This refers to the average amount of money a person receives within one year in a specific region. It is calculated by dividing the total income in a specific country by the total population of that country, and this value is always high in a developed country. High per capita income signifies high economic and financial security for the general population of that nation. The Gross Domestic Product (GDP) is also used to determine the per capita value. GDP is the market value of the final

product produced in a country for a particular period mostly quarterly or yearly. If the GDP of a nation is high, then that state is more developed.

iii. **Industrialization:** In a developed country, the rate of industrialization and employment is high. Thus, the general population depends less on agriculture. Such a nation will have higher export than imports hence the profits from the international trade will ensure that there is economic growth. The technological infrastructure of a developed nation is also high due to the high level of industrialization.

iv. **Political Stability:** The index for measuring political stability was developed by World Bank and it is a measure of the level of development of a country. Developed countries have stable political environment, low or no corruption, and high level of respect to the country's laws. Good Governance ensures that the level of corruption is low, transparency in running the government is high, and employment is based on merit and qualifications.

v. **General Living Standards:** The cost of living in a developed country is high compared to the less developed country, and this is because the majority of the population is willing and has the financial ability to afford quality goods and services which are expensive. Secondly, goods produced by local industries are mostly consumed as opposed to imported products which might be inferior. The general public has access to clean water and environment, affordable and quality housing and access to other social and economic amenities in the country like access to emergency services are fast.

vi. **Freedom:** A developed country has freedom for its citizens and respects the law. The freedom to worship, marry, own property, and access to information characterizes a developed nation. In the less developed countries, there are a lot of restrictions and citizens cannot do whatever they like freely.

Table 2: Classification of Countries According to Regions

Developed Economies by Region			
	Europe		
North America	**European Union**	**European Union**	**Major developed economies (G7)**

Canada United States	**EU-15** Austria Belgium Denmark Finland France	Iceland Norway Switzerland	Canada Japan France Germany Italy United Kingdom
	Germany Greece Ireland Italy Luxembourg Netherlands Portugal Spain Sweden United Kingdom		United States

Developed Asia and Pacific Australia Japan New Zealand	**EU-13** Bulgaria Croatia Cyprus Czech Republic Estonia Hungary Latvia Lithuania Malta Poland Romania Slovakia Slovenia		

Source: World Economic Situation and Prospects, (2019)

Developing Economies by Regions			
Africa		**Asia**	**Latin America and the Caribbean**
North Africa	**Southern Africa**	**East Asia**	**Caribbean**
Algeria	Angola	Brunei Darussalam	Bahamas
Egypt	Botswana	Cambodia	Barbados
Libya	Eswatini	China	Belize
Mauritania	Lesotho	Democratic People's Republic of Korea	Guyana
Morocco	Malawi	Fiji	Jamaica

Sudan Tunisia	Mauritius Mozambique Namibia South Africa Zambia Zimbabwe	Hong Kong SAR Indonesia Kiribati Thailand Malaysia Mongolia Philippines Republic of Korea	Suriname Trinidad and Tobago
		Samoa Singapore Solomon Islands Taiwan Province of China	

Central Africa	**West Africa**	**South Asia**	**Mexico and Central America**
Cameroon	Benin	Afghanistan	Costa Rica
Central African Republic	Burkina Faso	Bangladesh	Cuba
Chad	Cabo Verde	Bhutan	Dominican Republic
Congo	Côte d'Ivoire	India	El Salvador
Equatorial Guinea	Gambia	Iran	Guatemala
Gabon	Ghana	Maldives	Haiti
Sao Tome and Prinicipe	Guinea	Nepal	Honduras
	Guinea-Bissau	Pakistan	Mexico
	Liberia	Sri Lanka	Nicaragua

	Mali Niger Nigeria Senegal Sierra Leone Togo		Panama
East Africa		**Western Asia**	**South America**
Burundi Comoros Democratic Republic of the Congo Djibouti Eritrea		Bahrain Iraq Israel Jordan Kuwait	Argentina Bolivia Brazil Chile Colombia
Ethiopia Kenya Madagascar Rwanda Somalia South Sudan**c** Uganda United Republic of Tanzania		Lebanon Oman Qatar Saudi Arabia State of Palestine**c** Syrian Arab Republic Turkey United Arab Emirates Yemen	Ecuador Paraguay Peru Uruguay Venezuela

Source: World Economic Situation and Prospects, (2019)

3.6 Summary

In this unit, we can conclude by saying that a developed economy is one enjoying sustained economic growth and improved quality of life while a developing economy is an economy with weak economic and development base. The determinants of development includes level of income per capita, political stability, level of industrialization and increase in general standard of living.

In summary, this unit discussed extensively the concept of development in the context of a developed and a developing economy. This unit also outlined the major determinants of development which developing countries can strive to achieve in other to be classified as a developed countries.

3.7 References/Further Readings

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3.8 Possible Answers to SAEs

Answers to SAEs 1

1. A developed economy is defined as one with relatively high level of economic growth, improved standard of living, enhanced technological infrastructure and security.
2. The characteristics of a developed economy are hereby outlined: Human Development Index, income per capita, political stability, industrialization, freedom and living standards of the general population,

Unit 4 History Of Technology In Industrial Development

Contents

4.1 Introduction
4.2 Learning Outcomes (LOs)
4.3 Main Content
4.4 Industrial Revolutions and Technological Change
4.5 History of Technology Development in Nigeria
4.6 Summary
4.7 References/Further Readings/Web Resources
4.8 Possible Answers to SAEs

4.1 Introduction

Technology and technological progress have played an important role in development of human kind. This unit will evaluate the historical perspective of technology development in major economies from two perspectives: One account will take into consideration developments in terms of industrial revolutions. The second account involves historical perspective of catch-up process among countries related to technological changes in production process, in innovation and invention process, and developments that influenced further increases of expenditures for science and technology.

4.2 Learning Outcomes (LOs)

At the end of this unit, you should be able to:

- Discuss the history of technological development
- Trace the history of technological development from developed economies to the developing economies

4.3 Main Content

4.4 Industrial Revolutions and Technological Change.

Industrial Revolution marked the era when the society broke through from agrarian society to industrial domination. The First Industrial Revolution is a product of the eighteenth century. It encompasses variety of innovations, especially in the cotton industry of

England. It was the time of transformation from handicrafts to factory system of production. The very important effect of the Industrial Revolution was that it was selfsustainable, unlike the situation before the Revolution, where any improvement in conditions and opportunities were dampened by the increase in population, thus keeping income in the low level equilibrium trap (Malthusian trap). It is important to note that technological advancement made it possible to escape from the Malthusian trap where rising population matched or even outstripped growth in output, thus preventing any rise in GDP per capita. At this point Britain was able to accommodate population growth of up to 1.5 percent annually, unlike before 1700, where population growth above 0.5 caused real wages to fall. At the same time Britain became the richest European economy. Second, Britain went through a period of rapid structural change in employment. The change was towards much urbanized and industrialized labour force than in any other relatively advanced country (Crafts, 1998).

The common view of the industrial revolution is as a transition in which directions and possibilities of economic life were transformed enabling dramatic demographic challenges to be defeated over the long term. The changes involved here were complex and costs were considerable, both in the long and short run. However, the progress depended on new standards of economic efficiency, i.e. productivity growth. Attitudes, perceptions and understanding of production methods and opportunities were central to the process (Hoppit, 1990).

Although England was on the forefront of industrial revolution, other industrial nations in Europe did not lag behind. In 1785, Britain was still leading, however, the lead over France in the volume of output per capita from mines and manufactures was not as significant as fifty years before. Situation with the use of machinery and large furnaces and prevalence of large privately owned enterprises is much the same as for mines and manufactures in 1785 (Nef, 1943). It is obvious that the lead of Britain was not always progressing at the same pace. Continental Europe followed the pace and narrowed the gap between the leader and the followers. It seems that the rate of economic change in France during the most of eighteenth century was not less remarkable as that of Britain.

Although the concentration of technology and technology change is mostly attributing to the manufacturing industry, the technological change in agriculture was not unimportant. The agricultural productivity in Britain in eighteenth century rose but not as much as in industry. Historians even point out that mobility of labour and capital, essential to industrial growth, were made possible due to social and economic improvements in agriculture. In the countries industrializing today, especially in Asia, even though industrial sector has increased production

more rapidly than agriculture, output in agriculture has a steady rise and incomes in the rural areas have improved as well. Successful land reforms in Korea and Taiwan, unlike Latin American countries, were a very significant factor in the subsequent growth and development performance (Freeman & Soete, 1997).

Mokyr (1990) argues that innovations associated with the industrial revolution should be seen as "macroinventions". It is suggested that these are unpredictable, exogenous shocks that lead to advances in respective sectors. On the other hand, "microinventions" are generated through subsequent improvement, adaptation, and diffusion of technology, commonly involving learning by doing and learning by using. Much of the productivity increases can be attributed to the later.

There are several possible factors that may have influenced low TFP growth (and R&D) in the early nineteenth century Britain. Smallness of markets, weakness of science and formal education, inadequacies of the patent system, the continued high rewards to rent seeking, and the difficulties of securing compliant behaviour on the part of workers may have contributed to the slowdown to a certain level. As far as the government is concerned, its policy did not play an active role in correcting failures nor in any other way did it intervene to correct market failures, compared to the successful government role in the Asian success stories like Korea, and Taiwan. The policy had quite the opposite role. This was viewed in the crowding out effect of public spending during the Napoleonic Wars.

Interestingly, the ongoing transformation of economies after the first industrial revolution is labeled the second industrial revolution. Just as the first industrial revolution, the second one is continuation of development started by the first revolution. As mentioned earlier, these processes are more evolutionary than revolutionary. The innovation and inventions have emerged, but diffusion of the same is a much slower process.

The beginning of the Second Industrial Revolution is labeled with several distinctions in comparison to time before the revolution. These differences were given through three different ideas. First, the accounting got an improved role. From mere record of past events it developed into an applied science to help business decision-making. Secondly, engineers applied the results of pure science in order to get higher safety and economy in the construction of bridges and other works, and ships and boilers. The old methods, which included the rule of thumb and trial and error, were substituted with precise calculations and measurements. These new methods were of great importance in electrical engineering and slowly spread through mechanical engineering. Thirdly, there was

constantly increasing competition among manufacturers and widening markets. The application of scientific ideas for the workshop along with the cost accounting represented a birth of scientific management.

There was an important shift here regarding the scientific methods. During the first industrial revolution much of the innovations and inventions were based on trial and error methodology, and on the rule of thumb. As economies and operations developed, this methodology was not sufficient any longer.

Development of science introduced laboratories both in public and private domain. These laboratories were either merely for testing materials, or for research. A very important distinguishing characteristic of the second industrial revolution is the professionalizing industry. Functions, e.g. administrative, technical and managerial, are clearly distinguished along with the recognition of the qualification requirements for certain positions.

The exploitation of technologies associated with the Second Industrial Revolution continues today. Major innovations and inventions (e.g. internal combustion engine, electricity, etc.) are still in use today with some improved features. However, main principles and ideas are the same. The "New Economy" associated with advances in information and communication technology (ICT) is sometimes associated with transference of economies from industrial to information societies. However, advances made by using ICT are far from benefits associated with the two industrial revolutions and hence could constitute the next industrial revolution.

4.5 History of Technology Development in Nigeria

Nigeria is blessed with different ethnic groups each having their indigenously developed usable technologies suitable for their own way of life and environment. Taking a look from the coastal communities and the riverine areas down to the hinterlands, highland and the Sahara desert, people have developed and put into use local technologies suitable for their occupations, culture and transportation mode. However, it is not surprising to find that despite these differences, the peoples have common technologies. For instance the hoes and tools used on farms, the canoe water transportation, the palm wine tapping procedure, the use of town crier or big drum as a means of communication, use of locally made bows, guns and arrows as means of defence and hunting, etc.

Technological development in developing countries has always been part of human existence though crude at the initial stage but has transformed into a celebrated phenomenon in the present age. Technology has been

involved in the way man perceive his immediate environment, the means of livelihood especially in solving health care issues, dissemination of information and retrieval system and how to defend himself reveals the various levels of the scientific and technological approach to solving life's problems and challenges. Nigeria has no doubt played a worthy role in the various technological discoveries which largely influenced the global world.

The body that officially directs technology drive in modern Nigeria is the Federal Ministry of Science and Technology under the federal government and is saddled with the responsibility of facilitating the development and deployment of innovations, science and technology so as to enhance the pace of socio-economic development in Nigeria (Onipede, 2010). The Federal Ministry of science and technology was established on the 1st of January, 1980 by act Number 1 of 1980, as the successor organ of government to the National Science and Technology Development Agency (NSTDA), which was created in 1976. By January 1984, the ministry was merged with the Federal Ministry of Education which was then renamed, Federal Ministry of Education, Science and Technology. But in 1992, the ministry was scrapped and all the parastatals and research institutes were shared among other Ministries and Agencies such as the Federal Ministries of Industry, Agriculture, Health and National Agency for Science and Engineering Infrastructure (NASENI). The NASENI was established as an arm of government for the formation and implementation of science and technology policies and this later led to the formation of the Science and Technology Unit (STU). In 1993, the Federal Ministry of Science and Technology was again re-established and the STU under the presidency became the nucleus of the new Ministry. Consequently, some of its research institutes previously transferred to other Ministries were returned to operate under its purview. The Ministry is said to be currently supervising 17 Research and Development Institutions and interfacing with other cognate bodies to diversify the economy.

4.6 Summary

From the historical viewpoint, we can observe that technological development in has always been part of human existence. Technology has been involved in the way man perceive his immediate environment. The crude at the initial stage has transformed into a celebrated phenomenon in the present age. One of the components attributed to the fast growth of both European countries and successful East Asian countries is social capability due to technology evolution. Technology has evolved from different industrial revolutions.

In summary, this unit discussed the historical evolution of technology from crude tools to high technology thereby breaking the agrarian society. The First Industrial Revolution started as early as the eighteenth century encompassing varieties of innovations, especially in the cotton industry of England. It was the time of transformation from handicrafts to factory system of production. The Second Industrial Revolution saw the development of applied science to help business decision-making. In Nigeria technology development saw the establishment of the National Science and Technology Development Agency (NSTDA), in 1976; but presently called The Federal Ministry of Science and Technology.

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4.8 Possible Answers to SAEs

Module 2 Nature Of Technological Change And Socioeconomic Implications

Unit 1 Technological Change and Technology Life Cycle.
Unit 2 Technological Change and Technical Progress.
Unit 3 Socioeconomic Implications of Technological Change.
Unit 4 Industrial Competition and Technology Change

Unit 1 Technological Change and Technology Life Cycle.

Contents

1.1 Introduction
1.2 Learning Outcomes (Los)
1.3 Main Content
1.3.1 Technological Change and History: A Brief Introduction
1.3.2 Meaning of Technological Change and Technical Progress
1.4 Types of Technological Change
1.5 Technology Life Cycle
1 .6 Summary
1.7 References/Further Readings/Web Resources
1.8 Possible Answers to SAEs

1.1 Introduction

Technological progress is at the heart of human progress and development. Technological change is a loose concept that has multiple meanings. The concept originated from the concerns about unemployment due to technology, in the 1930's. It was subsequently applied to the study of economic growth, namely productivity. Current technology is the product of yesteryears innovation which has made life better for the people. Central to understanding the role of technology is the recognition that technology and technological progress are relevant to a wide range of economic activities. Therefore, there is the need to study the role of technology in socioeconomic development of developing countries.

1.2 Learning Outcomes (Los)

At the end of this unit, you should be able to:

- Discuss the history of technological change
- Highlight different types of technological change
- Explain technology life cycle

1.3 Main Content

1.3.1 Technological Change and History

A Brief Introduction

The concept of technology gave rise to two phrases such as: technological change and technological innovation, but in this unit, we are concerned with the former. Technological change is a phrase that emerged in the interwar years and that, by the 1950s, was "a modern sounding term", as a US Commission put it in 1960. A National Commission on Technology, Automation and Economic Progress, whose members included sociologist Daniel Bell and economist Robert Solow, was set up in December 1964 to study the effects of technological change upon people. After a year, the commission submitted its report titled *Technology and the American Economy* where it included a chapter titled "technological change" to show the importance of the issue to America. The report is massive, considering a series of contracted studies included as appendices. It deals entirely with technological change and the belief that technological change is a major source of unemployment. To the Commission, technology has, surely been a great blessing to mankind. Over the years, technological change has been aligned to the fulfillment of human purposes (National Commission on Technology, Automation and Economic Progress, 1966). To the Commission on Technology, Automation and Economic Progress, technological change is "new methods of production, new designs of products and services, and new products and new services.

1.3.2 Meaning of Technological Change and Technical Progress

Technological change is a very loose concept that has diverse meanings, depending on the discipline. But, at the nature of all the different definitions is technological change as *technological* "*advance*" or *"improvement"* or "*progress*". These terms are often alternative expression for technological change in the literature. According to

Dewhurts, technology change is a change of a firm's ability to produce a given level of output with a given quantity of inputs.

To economists, technological change has a more restricted meaning related to changes in *production techniques* or methods of production (industrial processes). That is, changes in techniques resulting from discoveries of new methods of production. The concept focuses on industrial techniques as factors of economic growth or productivity. A change in technique, in the wider sense of the term, as referring to changes in the methods of production (Kaldor, 1932).

In operational terms, technological change is defined as change in productivity due to changes in input (factors of production: capital and labor) used to produce output, or substitution of machinery for labor. "Technological change is considered as synonymous with modifications of ["a schedule which gives the outputs corresponding to different factor inputs"], i.e. changes in the production function" (May, 1947). In other words technological change is a *shift* in the production function (new combination of factors of industrial production) – as contrasted to movement along the production function or mere growth in the quantity of existing inputs to produce a given output.

Technological change is not all about improvement in the technical know-how. It means much more than this. Technological change can be defined from three different dimensions as:

(i) New technological inventions - Used to discuss the effects of new technologies in form of tools, facilities, services, etc, on the society and culture (change) and how the people adapt or *adjust*, to using new technologies.
(ii) New production techniques (industrial processes) - Used to study the role of technology as a factor of economic growth (productivity)
(iii) Change in the production function - Used for measurement

Kennedy and Thirlwall, (1972), defines technology as useful knowledge pertaining to the art of production while technical progress refers either to the *effects* of changes in technology on the economic growth process, or to "*changes* in technology itself (technical change). A few scholars make a difference between technical progress and technical change, like Kennedy and Thirlwall do. But in general, both progress and change are used interchangeably.

SELF ASSESMENT EXERCISE 1

Technological change and technological progress should not be used interchangeably. Discuss

1.4 Types of Technological Change

i. Productivity: - These are tools that help people to produce more in an hour. Example, accounting software that freed accounting departments from cumbersome paper-based processes. ii. Efficiency: - Technologies such as automation that allows firms to produce more with a unit of input.
iii. Knowledge: - Tools that help people to create manage and share knowledge such as internet. iv. Industries: - Through technology we create new business models and dispute old ones.
v. Environment: - Technology may create waste that harms ecosystems, the climate system and quality of life. In theory, technology such as renewable energy can also reduce some of this impact.
vi. Health: - Medicines, medical devices and other technologies that treat or prevent diseases.
vii. Economics: - Technology creates economic shifts. Example automation may cause short and long term disruptions to labor markets.

SELF ASSESMENT EXERCISE 2

i. Explain the different types of technological change

1.5 Technology Life cycle

Technology management involves carefully implementing the following 5 stages

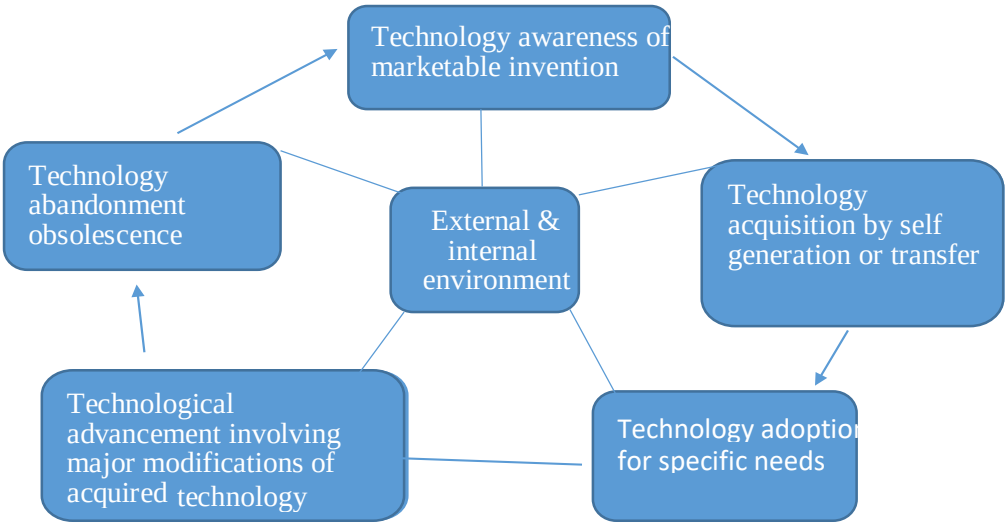

Fig.3 Technology life cycle

i. The first phase of technology life cycle is that the company has a formal mechanism to become aware of emerging technologies relevant to the need of the users or the public.

ii. The second phase involves the actual acquisition of a particular technology. At this stage, technical and economic feasibility study is conducted so as to decide whether to acquire the technology or not

iii. The third phase is the adaptation stage when the technology is eventually acquired for its own particular needs.

iv. The fourth stage is driven by new innovations as a result of feedback gained in the use of technology. It could be from creative ideas that comes from within.

v. The last phase of the technology life cycle is the abandonment phase. This is the most critical because this is when technology decisions are made concerning the obsolescence of a particular technology. Timing for the adoption of new technologies can be done with input and information from R&D department, production and marketing divisions.

SELF ASSESMENT EXERCISE 3

i. Discuss the 5 stages of technological life cycle.

1.6 Summary

In this unit, we may conclude that technological change is a phrase that emerged in the interwar years and that, by the 1950s, it became a modern sounding term. Technological change or technological progress is both used interchangeably because technical progress is difficult to discuss in precise language. Technological change is defined with a wide range of meanings and interpretations: inventions, production techniques, shifts in production function. The uses of the concept oscillate between the large and the restricted, from social (including economic) change due to technology, to change in technology.

We discussed broadly on technological change, types of technological change and technology life cycle. Technological change also known as technical progress is not all about improvement in the technical know-how. It means much more than this. It involves new technological inventions, that is, how new technology affects the society and how the people adjust to using such new technologies. The types of technological change include productivity, efficiency, knowledge, industries, environment, health and economics. For effective management of technology, the following five crucial phases are of essence - creation of awareness, acquisition, adoption, advancement and abandonment. These phases are referred to as technology life cycle.

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1.8 Possible Answers to SAEs

Answers to SAEs 1

1. Technological progress is at the heart of human progress and development. Technological change is a loose concept that has multiple meanings, technological progress are relevant to a wide range of economic activities.

Answers to SAEs 2

1. **Knowledge**: - Tools that help people to create manage and share knowledge such as internet. **Industries**: Through technology we create new business models and dispute old ones. **Environment**: Technology may create waste that harms ecosystems, the climate system and quality of life. In theory, technology such as renewable energy can also reduce some of this impact.

Answers to SAEs 3

1. The first phase of technology life cycle is that the company has a formal mechanism to become aware of emerging technologies relevant to the need of the users or the public.
2. The second phase involves the actual acquisition of a particular technology. At this stage, technical and economic feasibility study is conducted so as to decide whether to acquire the technology or not
3. The third phase is the adaptation stage when the technology is eventually acquired for its own particular needs.
4. The fourth stage is driven by new innovations as a result of feedback gained in the use of technology. It could be from creative ideas that comes from within.
5. The last phase of the technology life cycle is the abandonment phase. This is the most critical because this is when technology decisions are made concerning the obsolescence of a particular technology.

Unit 2 Technological Change And Technical Progress

Contents

2.1 Introduction
2.2 Objectives
2.3 Main Content
2.4 The Production Function
2.5 The Role of Technological Progress in Economic Growth
2.6 Summary
2.7 References/Further Readings/Web Resources
2.8 Possible Answers to SAEs

2.1 Introduction

Technological progress has many dimensions. It could mean larger quantities of output, production of new and better products or the production of a larger variety of products. Technological progress leads to increases in output for given amounts of capital and labor. In this unit, we will discuss the production function and the relationship between technical progress and growth.

2.2 Learning Outcomes (LOs)

At the end of this unit, student should be able to:

- Explain the production function
- Understand the role of technical progress in achieving economic growth

2.3 Main Content

2.4 The Production Function

Production function shows the relationship between the quantity of output and the different quantities of inputs used in the production process (Alani, 2012). In other words, it means the total output produced from the chosen quantity of various inputs. Therefore, it is a technical relationship between inputs and outputs.

In the cause of technological progress, new inventions may result in the increase of the efficiency of all methods of production. Equally, some techniques may become inefficient and obsolete and will not be useful in production anymore. These changes constitute technological progress.
This technological progress can be shown in a diagram with an upward shift of the production function or a downward movement of the production isoquant. Figure 4a shows that the same output maybe produced by less factor inputs, while Figure 4b shows that more output maybe obtained with the same inputs.

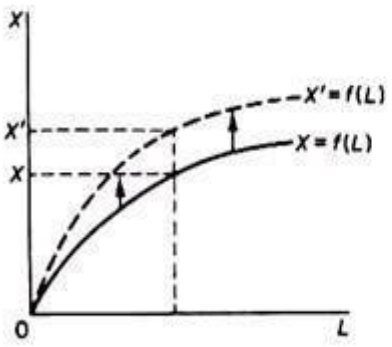

Figure 4a: Upward shift of the PP

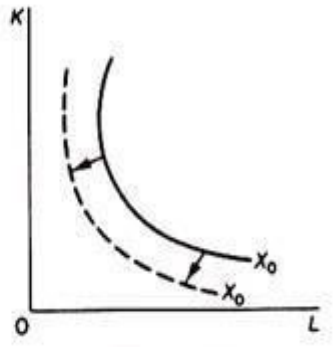

Figure 4b: Downward shift of the PP

Figure 4: Effect of Innovation in Production Process (PP)

Technical progress also changes the shape of the isoquant. According to Hicks, there are three types of technical progress depending on its effect on the rate of substitution of the factors of production.

(i) Capital-Deepening Technical Progress:
When the capital-labour (K/L) ratio is constant and the marginal rate of substitution of labour for capital (MRS_{LK}) increases, it is assumed that technical progress has capitaldeepening. The implication is that technical progress increases the marginal product of capital by more than the marginal product of labor. Therefore, the ratio of marginal products (MRS_{LK}) decreases in absolute value. Since the slope of the isoquant is negative, the technical progress in this case increases the $MRS_{LK.}$ The slope of the shifting isoquant becomes less steep along any given radius as shown in Figure 5.

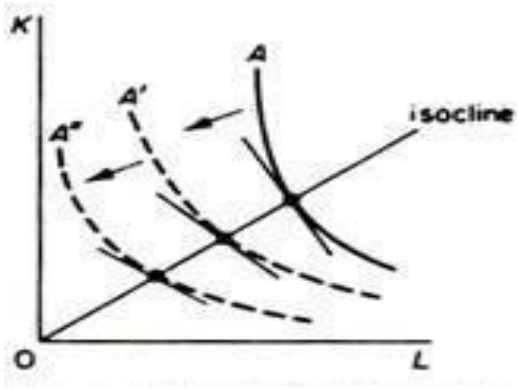

Figure 5: Capital deepening technical progress

(ii) Labour- Deepening Technical Progress:
A situation where along a radius through the origin with constant K/L ratio, the $MRS_{L.K}$ increases, then we can say that the technical progress is labour-deepening. This means that the technical progress increases the MP_L faster than the MP_K. Thus, $MRS_{L.K}$ which is the ratio of the marginal products $[(\partial X/\partial L)]/[\ \partial X/\partial K)]$, increases in absolute value (but decreases if the minus is taken into consideration). The downwards-shifting isoquant becomes steeper along any given radius through the origin as shown in Figure 6

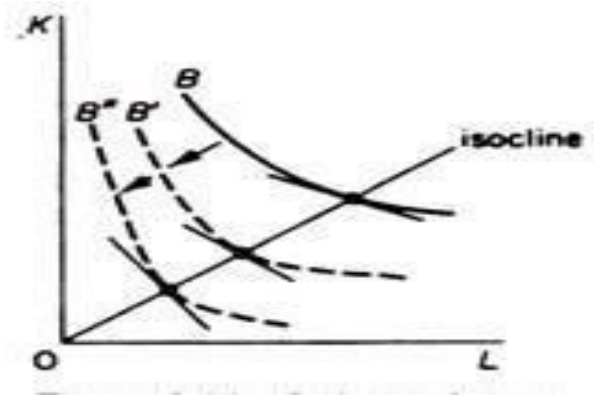

Figure 6: Labour-deepening technical progress

(iii) Neutral-technical progress:
Technical progress is neutral if it increases the marginal product of both factors by the same percentage, so that the MRS_{LK} (along any radius) remains constant. The isoquant shifts downwards parallel to itself (Figure 7)

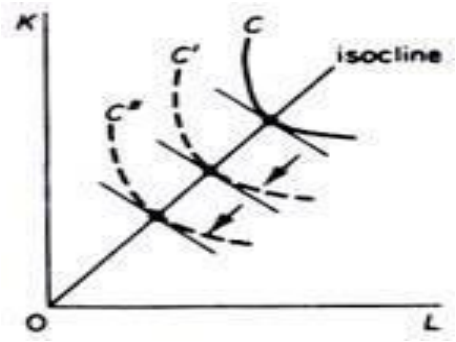

Figure 7: Neutral technical progress

SELF ASSESMENT EXERCISE 1

i. Explain the three stages of technical progress as outlined by Hicks

2.5 The Role Technological Progress in Economic Growth

Traditionally economists view the process by which goods and services are produced as one that combines capital, labour, and other factors of production using a particular technology. The relative efficiency with which an economy produces goods and services with a given level of capital and labour is referred to total factor productivity (TFP) in other words a measure of technical progress. But, the relationships between income growth, technological progress, capital accumulation, and welfare are, of course, much more complex than can be summarized in a simple measure of TFP, partly because each factor of production and the technology with which factors are combined are dependent on one another. Even though measures of TFP and its progress give us a sense of the relative dispersion of technological progress, they tell us little about the mechanisms by which technology influences development. Technological progress involves much more than doing the same things better or with fewer resources. It is more dynamic, involving both the creation of new products and production techniques as well as the spread of these techniques across firms and throughout the economy. Technological progress is beneficial to developing countries, it can also be disruptive. While the mechanisms by which technological progress contributes to socioeconomic development are in some sense obvious, the following deserve special mention:

I. Technological progress in one sector can create new economic opportunities in other sectors.

Lower production costs can create whole new products, or even sectors. A new-tothe-market innovation in one sector can result in a flowering of activity in other sectors by creating a demand for and supply of goods and services that did not exist previously Success in one activity may well lead to further innovation and technological deepening. The move

from producing carnations to more fragile and expensive roses is an example. Another example is the shift to higher-quality products such as chilled rather than frozen fish fillets. Yet another example of deepening is palm oil production in Indonesia, where new processes include the production of new varieties of palms; the introduction of new crude and processed palm oil refining technologies; and, notably, the introduction of oleo chemical technologies.

II. The benefits of a new technology can extend well beyond the immediate sector in which the technology exists.

This is the case if the initial product is an important intermediate good in the production of other goods, for example, telecommunications or reliable electrical service.

III. Technological progress can yield improvements in quality products.

Such improvements can enable a developing country to penetrate more demanding consumer and intermediate markets. This can be as simple as employing machinery and equipment that produce goods and services that correspond to the more exacting expectations and standards of consumers and business clients in high-income countries. Technology in this sense extends beyond engineering technology to include management techniques.

IV. Technological progress can spur development by lowering the costs of production and enabling the exploitation of increasing returns to scale.

By improving the efficiency with which existing products are produced, new technologies can open up the possibility of increasing output and, assuming that markets are available, taking advantage of previously unexploited increasing returns to scale.

V. The disruptive nature of technological progress.

The disruptive nature of technological progress can generate important benefits to society by spurring competition. For example, the introduction of mobile phone technology in several developing countries has introduced an important element of competition not only in the telecommunications sector, but also in banking and other information-sensitive sectors. Hence, many of the informational asymmetry generated by lack of effective communications by middlemen used to exploit them have been eliminated.

SELF ASSESMENT EXERCISE 2

Enumerate the role of technical progress in economic growth

2.6 Summary

In this unit, we can conclude that the production function is the technical relationship between inputs and outputs. During technological progress, new inventions result in the increase of the efficiency of all methods of production. Technological progress could be capital deepening, labour deepening or neutral deepening. Technological progress can have tangible and positive effects on economic growth and if well managed and utilized can lead to socioeconomic development.

In our discussion, we understood that technological progress leads to increases in output for a given amounts of capital and labour. It leads to the creation of economic opportunities in other sectors. It can also result in improvements of product quality as well as reduction in cost of goods and services. In addition, the disruptive nature of technological progress generates benefits to the society by spurring industrial competition.

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2.8 Possible Answers to SAEs

Answers to SAEs 1

(i) Capital-Deepening Technical Progress: When the capital-labour (K/L) ratio is constant and the marginal rate of substitution of labour for capital (MRSLK) increases, it is assumed that technical progress has capitaldeepening.

(ii) Labour- Deepening Technical Progress: A situation where along a radius through the origin with constant K/L ratio, the MRSL.K increases, then we can say that the technical progress is labour-deepening.

(iii) Neutral-technical progress: Technical progress is neutral if it increases the marginal product of both factors by the same percentage, so that the MRSLK (along any radius) remains constant.

Answers to SAEs 2

Technological progress in one sector can create new economic opportunities in other sectors. Lower production costs can create whole new products, or even sectors

The benefits of a new technology can extend well beyond the immediate sector in which the technology exists.

The disruptive nature of technological progress. The disruptive nature of technological progress can generate important benefits to society by spurring competition.

Unit 3 Socioeconomic Implications Of Technological Change

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3.1 Introduction

The United Nations interest in new technologies is spurred by the opportunities of its ability to address and monitor the ambitious Sustainable Development Goals (SDGs). The 2030 Agenda for Sustainable Development, adopted by world leaders in 2015, aims to "leave no one behind" and therefore puts forward a broad and ambitious agenda for global action on sustainable development. The (SDGs) require new modalities for development, including bringing technology and innovation into the foreground of development strategies. Science, technology and innovation (STI) which is SDG 9 (Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation), are key enablers of most of the Goals. Therefore, harnessing new and existing technologies could be transformative in achieving the SDGs and creating more prosperous, sustainable, healthy and inclusive societies.

3.2 Learning Outcomes (LOs)

At the end of this unit, you should be able to:

- Discuss what is meant by sustainable development
- List the sustainable development goals
- Explain the role of technology in socioeconomic development.

3.3 Main Content

3.3.1 Definition and Explanation of Sustainable Development

Sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The conception of needs is not just simply material needs, but it includes freedom to think, freedom to act and participate, all amounting to sustainable living. In 1987 the United Nations Commission on Environment and Development issued the Brundtland Report which highlighted that environmental maintenance, equity and economic growth can be achieved simultaneously with the enhancement of the resource base. It emphasized three fundamental components of sustainable development: economic growth, environmental protection and social equity.

Socioeconomic development is all about improving people's welfare; hence human being is the center of concerns for sustainable development. For socioeconomic development to be sustainable, it must be both inclusive and environmentally sound to reduce poverty and ensure prosperity for today's population and to continue to meet the needs of future generations. It is efficient with resources and when carefully planned to deliver both immediate and long-term benefits for people, the planet, and prosperity.

Technological change is at the center of achieving the three pillars of sustainable development. These pillars include economic growth, environmental stewardship, and social inclusion across all sectors of development; from cities facing rapid urbanization to agriculture, infrastructure, energy development and use, water availability, and transportation. Technological change involves the use of the ICTs, internet, machine learning, artificial intelligence, robotics, 3D printing, biotechnology, renewable energy technologies, satellite, and drone technologies. These represent a significant opportunity to achieve the 2030 Agenda for Sustainable Development and the Sustainable Development Goals. Technological change could contribute to many, if not all of the goals, especially those related to hunger, health, education, clean energy, industry, innovation and climate change.

3.3.2 Goals of Sustainability

The Sustainable Development Goals (SDG) grew out of the Millennium Development Goals (MDG) that claimed success in reducing global poverty while acknowledging there was still much more to do. The SDG

eventually came up with a list of 17 points which are the targets. Among others, this list includes the following:

- To end poverty and hunger
- To achieve better standards of education and healthcare, particularly as it pertains to water quality and better sanitation
- To achieve gender equality
- To achieve sustainable economic growth while promoting jobs and stronger economies
- For stainability to include health of the land, air, and sea
- To have sustainable consumption and production pattern
- Sustainable cities and communities
- Peaceful and strong institutions
- Partnership that will help in achieving the goals.

3.4 Positive Impacts of Technology on Socioeconomic Development

Technological change can contribute to socioeconomic development through the following ways:

i. *Ending poverty and monitoring the progress of poverty alleviation programmes*: - One of the goals of sustainable development is ending poverty in all its forms and this requires not just income, but that, all peoples especially the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services. Innovation and new technologies can contribute to the eradication of poverty by raising living standards and contributing to economic diversification. For example, renewable energy or solar technologies can be used to provide electricity in rural areas while internet can be used to detect water contamination as well as in purify the water. Also, machine learning and ICT can also be used to create measures, develop and monitor the effectiveness of anti-poverty programs and progress towards the Sustainable Development Goals. Models based on both mobile phone activity and airtime credit purchases have been shown to estimate multidimensional poverty indicators accurately (UNCTAD, 2016).

ii. *Improvement in education*: - New digital platforms, including open online courses, allow for open access and participation through the World Wide Web. The online technology do not just involve online video lectures but also incorporates social sharing features, interactive quizzes and assignments, supplementary resources (e.g. books, articles), community teaching assistants, etc. Technology has the potential of providing self-paced learning, lower cost quality teaching as well as good content and methods. Open hardware and software platforms have the potential to enhance the educational experience in developing countries. For instance 3D

printing is being used as a tool for education in primary, secondary, and post-secondary schools in developed countries.

iii. *Improving agricultural production and food security:* - It is estimated that about 795 million people are undernourished, with the majority living in developing countries and rural areas. With new and existing technologies, the issue of food insecurity can be addressed. There are basically four dimensions of food security, namely, food availability, access, use and stability. The use of irrigation technologies, improvement of soil fertility and use of genetic modification, can help to increase food availability in developing countries. The issue of food accessibility can be solved using postharvest and agro-processing technologies, while the use of early warning systems can reduce the problem of instability in food supply.

iv. New technologies such as machine learning, is being used to detect soil and crop quality. For instance in Nigeria, the use of technology has helped in building financial resilience to weather and climate changes that negatively affect the incomes of agricultural workers.

v. *Technology helps to promote access to and efficiency of energy*: - Access to electricity plays a critical role in improving livelihood, facilitating new productive and income-generating activities in an economy. The development of decentralized renewable energy systems can provide electricity in developing countries. Solar energy is presently used as an alternative means of generating energy in many parts of the world. Energy demand can also be managed with the use of big data technologies. Smart grids can increase energy distribution and production by allowing households with solar panels on their roofs to feed surplus energy back into the electricity grid. The real-time information provided by smart grids help utility companies to respond to demand for power supply, costs, and emissions as well as avert major power outages. For instance, Zenatix, a Delhi company, deploys smart meters and temperature sensors to monitor energy meters and help households and offices reduce energy consumption through message-based alerts. The transition from fossil fuels to renewable energy could be a catalyst for industrial development and structural change if backed by finance and investment, technology transfer and other supportive measures to ensure adequate energy supply at reasonable costs. Though such a transition requires overcoming important technological, economic, financial and governance obstacles in developing countries.

vi. *Enabling economic diversification and transformation, productivity and competitiveness*: - For countries with requisite technological capabilities, technologies may support structural transformation, improve living standards, increase productivity and reduce production costs and prices. New technologies,

including artificial intelligence, have the potential to promote new sources of employment and income and access new opportunities that were previously out of reach. New frontier technologies provide opportunities for technological advancement needed to restructure their economies. For example, a few countries such as the Republic of Korea and Taiwan have achieved rapid economic growth by advancing in some specific technology sectors such as electronic goods. Technologies, including artificial intelligence, have the potential to promote new sources of employment and income and access new markets and opportunities previously out of reach.

vii. *Promote social inclusion*: - New technologies enable large segments of populations in developing countries to innovate, coordinate, and collaborate. Grass-roots innovation facilitates the involvement of different networks such as academics, activists and practitioners experimenting with alternative forms of knowledgecreation and innovation processes. For example, a fabrication laboratory established by the University of Nairobi has used 3D printing to develop a sanitation solution for slums and a vein-finder device to help administer injections in infants. New platforms provide innovative ways to coordinate by distributing work, building twosided markets for the sharing economy, and providing personalized digital learning within and outside established educational institutions. Digitally-enabled open and collaborative innovation enables knowledge and technology to be produced across a multiplicity of actors and institutions, drawing from a large pool from both formal and informal knowledge.

viii. *Improving the health status of individuals*: - Technologies could address health challenges by distributing interventions, monitoring and assessing health-related indicators, and developing gene editing techniques. Countries are increasingly using geographic information systems and unmanned aerial systems to better connect citizens with existing health systems. For example, during a typhoid outbreak in Uganda, the Ministry of Health used data-mapping applications to allocate medicine and mobilize health teams. For instance, in Rwanda, the government partnered with a robotics company, known as Zipline, to address maternal mortality by using drones to deliver blood to medical facilities thereby reducing the time needed to procure blood from four hours to fifteen minutes. New technologies hold promise for making public health interventions more effective by using big data and digital simulations for forecasting. Advances in biotechnology allows for specific gene editing for human medicine and personalized treatments.

3.5 Negative Impacts of Technology on Socioeconomic Development

While digital platforms may create opportunities for socioeconomic development in developing countries, digitalization may also present certain development challenges as identified:

i. *Automation and future jobs*: - The application of new technologies provides an opportunity to address the development goals, but, they can disrupt economic development, thereby posing new challenges for policy makers and the society at large. Automation from the convergence of artificial intelligence, machine learning, and big data could impact employment, productivity, globalization, and competition in unclear and potentially negative ways. While technologies can be expected to create new jobs and opportunities, it also has the potential to disrupt existing labour markets and productive sectors. For example, the World Bank estimates, that two thirds of all jobs could be susceptible to automation in developing countries in coming decades (UNCTAD, 2019). The impacts of automation varies according to a range of factors such as the levels of industrialization and development, skills and capacities, labour costs, technological capabilities, infrastructure and policies encouraging or discouraging automation. Although jobs in developing economies tend to be less exposed to automation, developed and developing countries have started to converge in this regard in the last decades. Consequently, automation can have important impacts on the economies of developing countries in the future. Recently, new technologies have been substituting workers only in specific tasks, but they have not replaced entire occupations. Rather than eliminating occupations, technology changes how jobs are performed, and the number of humans needed to carry them out.

ii. *Widen Income Inequalities*: - Despite the new opportunities for trade and development, dynamics could lead to widening income inequalities and increased polarization. The evolving digital connectivity has also been accompanied by online labour platforms that provide those with required skills new income-generating activities for people in developing countries. But there is fear that oversupply of job seekers online could reduce bargaining power and low wage rate.

SELF ASSESMENT EXERCISE 1

i. Enumerate the positive implications of technology change

ii. Discuss the negative role of technology in socioeconomic development of developing countries.

3.6 Summary

Technological change offers a significant opportunity to achieving the 2030 Sustainable Development Goals. Sustainable development is development that meets the needs of the present generation without compromising that of the future. New and emerging technologies have many advantages to the developing countries, though, it also poses new challenges for policy-making, threatening to outpace the capacity of governments and society to adapt to the changes that new technologies bring about. Automation could impact employment, productivity, globalization, and competition in unclear and potentially negative ways. Therefore, harnessing new technologies could be transformative in achieving the SDGs and creating more prosperous, sustainable, healthy and inclusive societies.

Sustainable development is defined as the development that meet the needs of the present generation without compromising the needs of the future generations. It affords the future generation the same opportunity to prosper as the present generation. We know that development comes with higher material welfare by increasing national output of goods and services on one hand and on the other hand it pollutes the environment badly by overuse and misuse of natural resources. Hence the need for environmental protection.

Technological change represents a significant opportunity to achieve the 2030 Agenda for Sustainable Development and the Sustainable Development Goals. Rapid technological change could contribute to support poverty eradication efforts, improve food security, promote energy access and efficiency, enable structural economic transformation, support social inclusion, combat disease, and enable access to quality education.

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3.8 Possible Answers to SAEs

Answers to SAEs 1

- Ending poverty and monitoring the progress of poverty alleviation programmes:
- Improvement in education
- Improving agricultural production and food security
- New technologies such as machine learning, is being used to detect soil and crop quality.

- Automation and future jobs
- Widen Income Inequalities

Unit 4 Industrial Competitions And Technology Change

Contents

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4.3.2 Competitive Parity
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4.5 Competition Policy and Economic Growth
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4.8 Possible Answers to SAEs

4.1 Introduction

Competition is the process of winning business in a crowded market. It makes production more efficient, cheaper and of better quality. Without competition, economic and technological progress or change will be slow or may not exist especially in developing nations. Technological change (TC) is the overall process of innovation, invention and diffusion of technology or processes. It derives from three major sources which are summarized as Research and Development (R&D), learning-by-doing and spillovers.

4.2 Learning Outcomes (LOs)

At the end of this unit, you should be able to:

- understand the meaning of industrial competition
- know the components of industrial competition

4.3 Main Content

4.3.1 Industrial Competition

Businesses that sell similar products or services are always competing with each other. For instance, if your business is education technology, your competitors are other businesses creating education tech apps. Industry competition is so fierce that companies have to fight for the business of potential customers. This could lead to a negative view about

competition. The state of industry competition can have a major influence on strategy even though competition has some negative implications. A product might be unique but it does not mean that there are no competitors for such product. As its growing, new competitors will definitely emerge. A competitive matrix can be a helpful tool for thinking through who your competitors are and how your product or service is different from theirs. There are five basic forces (Porter's Five Forces) that drive competition in an industry: Industry rivalry, threat of new entrants, bargaining power of customers, bargaining power of suppliers and threat of substitutes. They are:

i. **Industry Rivalry -** Industry rivalry describes a case of competitors within an industry jockeying for position, using tactics such as product launches, advertising competition, and price competition. When business owners feel competitive pressure or see an opportunity to improve their current position, rivalry can become intense. Sometimes it can even lead to industry disruption. The transportation industry in Nigeria is an example of industry rivalry.
ii. **Threat of New Entrants** - New industry players are always a threat to existing businesses. The seriousness of the threat, however, will depend on barriers to entry and the reaction from current competitors in the marketplace. If barriers to entry are low (example, if it costs little to enter the industry or if there are few economies of scale in place), new entrants can weaken the existing businesses' position in the market.
iii. **Bargaining Power of Customers** - Customers can affect the pricing. Prices are affected by how many customers purchase a product or service, how significant each customer is to a company and the cost to a customer of switching from one business to another. If a company has a limited but powerful client base purchasing its product, they can often dictate their terms and drive prices down.
iv. **Bargaining Power of Suppliers** - If customers can drive prices down, suppliers can drive prices up. This force is driven by the number of suppliers, the uniqueness of the supplier's product, and how much it would cost a company to switch from one supplier to another. If a company has few suppliers, it becomes dependent on them and the suppliers in turn will have the power to increase their prices.
v. **Threat of Substitutes** - The demand for substitutes can reduce the demand for industry products and services. If a company increases its prices, customers are more likely to switch to cheaper alternatives. This can significantly reduce a company's power within the industry.

4.3.2 Competitive Parity

Competitive parity is the optimal expenditure on branding and advertising activities required for a firm to stay at par with the competitors of a particular brand, product. Promotional budget is allocated based on the scrutiny of optimal level of market competition. The war between Coca Cola and Pepsi is an example of such competition. The respective firms will first check their competitor's presence in any new place they want to establish their presence. Accordingly, they budget their advertising and promotional expenses. Businesses use competitive parity as a defensive strategy to maintain their reputation, brand and position without necessarily overspending on their financial resources.
One of the merits of using this method to calculate the advertising and branding expenditure is that a business will not be too far away from competitors in the sense that their spending and visibility will be at par.
Another advantage is that it is more simplified than using sales forecast and demand forecast to determine what they will spend on branding and advertisement in the future. Though this can vary from one company to another depending on the situation on ground. For a company that is not doing so well financially, this kind of advertising and branding budgeting may not augur well for them.

For new entrants into the market, this kind of budgeting is not always advised unless the market in itself is very new and still in its emerging stages in which case it makes sense as all the competitors are relatively new too. Hence; they will have to bear huge opportunity costs in order to match up to the budgets of existing firms in terms of advertising and branding. Similarly, for products that are different in nature, it is not worth spending exorbitantly on branding and advertising.

Two companies might have products that are competitors but they may also have products that are not competitive. A look at the advertising behavior of certain competitors shows a fierce competition existing between them, including matching their spending on advertising and branding. This kind of competing behavior exists between Flipkart, Amazon and Snap deal.

4.4 Competitive Advantage

Competitive advantage is the superiority gained by an organization/firm when it can provide the same value as its competitors but at a lower price, or can charge higher prices by providing greater value through differentiation. In other words, *Competitive advantage* is the leverage a business has over its *competitors.* It is also an attribute that allows a firm to outperform its competitors by offering consumers greater value, either by means of lower prices or by providing greater benefits and service that

justifies higher prices. Other competitive advantage strategies innovators use to outdo their competitors are:

i. *Brand:* Brand loyalty is one of the biggest competitive advantages any business can capitalize on. An effective brand image and positioning strategy leads to customers becoming loyal to the brand and even paying more than usual to own the brand's product. Apple is a perfect example when it comes to brand-related competitive advantage.
ii. *Financial advantage:* Some companies enter the market with huge funding and disrupt the system by providing some really enticing offers or providing the products at really low prices. This acts as a competitive advantage as other companies often fail to respond to such tactics.
iii. *Barriers to Entry & Competition:* Businesses often make use of natural and artificial barriers to entry like government policies, access to suppliers, patents, trademarks, etc. to stop others from becoming a close competitor.

SELF ASSESMENT EXERCISE 1

i. Discuss the term industrial competition
ii. Explain the strategies used by innovators to achieve competitive advantage

4.5 Competition Policy and Economic Growth

Competition tends to align private and social objectives. Given enough competition and the absence of externalities, markets should produce socially efficient outcomes, because firms that do not serve their customers efficiently will lose out to those that do. On the other hand, competition can reduce or even destroy long-run economic growth. This is because, in many cases, the main reward to a successful innovator comes in the form of monopoly rents that a firm captures by learning how to supply something its competitors cannot, or at a cost competitors cannot match. Increased competition, however, reduces a firm's ability to capture monopoly rents and discourages the innovations that trigger longrun growth. Indeed, this is what the first generation of Schumpeterian growth models predicted. Product market competition is good for growth because it forces firms to innovate in order to survive. Also, competition from a new technology drives improvements in previously developed technologies.

The Schumpeterian theory contains a variety of channels through which competition might, in fact, spur economic growth. One of these channels

is by creating barriers to entry which raises the cost of introducing a new technology to the outside firm. Invariably, this reduces both the incentive to perform R&D and the growth rate. Let us consider next the role of agency costs that allow managers to operate businesses in their own interests rather than maximizing the owners' profits. To the extent an increase in competition reduces the firm's flow of profits, it reduces the scope for managerial slack and forces managers to innovate more often. Competition stimulates innovation by depriving managers of the opportunity to enjoy a quiet life. For firms that are already producing and earning profits, the incentive to innovate is lower, since innovations would affect existing profits. Despite this effect, incumbent firms might engage in at least some R&D if there were decreasing returns to R&D effort at the firm level. An increase in the intensity of competition tends to reduce the absolute level of profits a successful innovator realizes. It equally tends to reduce the profits of an unsuccessful innovator. Therefore, competition can have a positive overall effect on the rate of innovation, because firms will try to innovate in order to escape competition.

Another channel through which increased competition can stimulate economic growth is described in a model of fundamental and secondary innovations created by Aghion and Howitt (1996). The fundamental research is the basic research that generates the underlying ideas leading to new products. Meanwhile, secondary research is applied research or development that helps in the realization of the potential created by the fundamental research. In the Aghion and Howitt model, society faces a tradeoff between engaging in basic research or engaging in applied developmental research. Most times the output of fundamental research is more difficult for a private firm to appropriate because it is underprovided in the absence of government support to the extent that existing research is reallocated from secondary (applied) toward fundamental (basic) research. And an increase in the intensity of competition indeed leads to such a reallocation. That is, when new products can compete more freely with existing ones, someone who makes a basic innovation can attract developers more easily, which raises the returns to the basic innovation. Thus, more competition raises the rate of economic growth by encouraging a reallocation toward more fundamental research. To the extent competition policy authorities, regulators, or trade liberalizers might have shrunk from promoting competition for fear that innovation-promoting profits might erode, the new growth theory suggests they should take a more aggressive stand in favour of more competitive markets.

SELF ASSESMENT EXERCISE 2

Discuss the importance industrial competition in driving economic growth

4.6 Summary

In this unit we can conclude that competition is necessary for economic and technological progress or change in developing nations. While technology refers to the processes used by a firm to transform inputs into output, technological change is a change of a firm's ability to produce a given level of output with a given quantity of inputs. We are presently in an environment where technology is advancing and globalization is increasing rapidly. The implication is that distances are getting shorter, which results to increase in competition, customer expectations being high, and occurrence of disruptions in the economy. Competition is a struggle and whose survivors are businesses that succeed in creating, adopting, and improving new technologies. For a business or an organization to realize competitive advantages, it should be able to adapt to the changing trends and new generations.

This unit discussed extensively industrial competition and technology change. There are five basic forces that drive competition in an industry: Industry rivalry, threat of new entrants, bargaining power of customers, bargaining power of suppliers and threat of substitutes. Competitive advantage is the control a business has over its competitors by offering consumers greater value, lower prices and providing benefits and service attractive to the customers. The Schumpeterian theory advocates that by creating barriers to entry as a channel through which competition might, in fact, spur economic growth.

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4.6 Possible Answers to SAEs

Answers to SAEs 1

1. Industry competition is so fierce that companies have to fight for the business of potential customers. This could lead to a negative view about competition.

Answers to SAEs 2

1. competitive advantage strategies innovators use to outdo their competitors by Brand: Brand loyalty is one of the biggest competitive advantages any business can capitalize on
2. Financial advantage
3. Barriers to Entry & Competition

Module 3 Technology Transfer, Diffusion And Adoption

Unit 1 Technology Transfer and Socioeconomic Development
Unit 2 Technology Diffusion and Adoption
Unit 3 Economic Theories of Technology Change
Unit 4 Issues of Technology Acquisition in Developing Countries.

Unit 1 Technology Transfer and Socioeconomic Development

Content

1.1 Introduction
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1.3.1 Definition and Explanation of Technology Transfer
1.4 Classification of Technology Transfer
1.4.1 Stages of Technology Transfer Process
1.5 Technology flow Channels to Developing Countries
1.5.1 Formal Flows of Technological Transfer
1.6 Summary
1.7 References/Further Readings/Web Resources
1.8 Possible Answers to SAEs

1.1 Introduction

It is expected that the student must have been familiarized with the explanations of technology change. This unit explains the meaning of technological transfer as well as the different categories of technology transfer.

Technology transfer is a process by which various elements of technology are transferred from one individual or group to another for meeting the needs of business or society. Technology transfer is effected through different channels of contact hence the need to highlight and discuss the approaches to technological transfer in this unit. This will give the student a background knowledge and understanding of subsequent units.

1.2 Learning Outcomes (LOs)

At the end of this unit, you should be able to:

- Discus the meaning of technology transfer
- Explain the different classes of technology transfer
- Enumerate the different approaches through which technology can be transferred.

1.3 Main Content

1.3.1 Definition and Explanation of Technological Transfer

Technology developments are happening around the world and this new developments must be explored and adopted by those who developed them or acquired by those who need them. Technology can be acquired in two ways; either it is developed through research and development (R&D) or it is purchased by the person or country that needs it. Therefore, it is this second way of acquiring technology that is commonly referred to as 'Technology Transfer.' This is a process which is very crucial for the wide utilization, application and up-gradating of already developed technology.

According to Rani, Rao, Ramarao and Kumar (2018) technology transfer is the process of transferring scientific findings, knowledge, manufacturing process, etc., from one organization to another for the purpose of developing them further as well as for commercial purposes. Technology transfer enables the flow of technology from one source to another (receiver). The holder or owner of the knowledge is called the source while the beneficiary of such technology is the recipient .

Technology transfer is a process by which various elements of technology are transferred from one individual or group to another for meeting the needs of the society.

SELF ASSESMENT EXERCISE 1

i. Discuss the meaning of technological transfer

1.4 Classification of technological transfer

Technological transfer involves providing technology developed from one user to another user and it can be categorised differently as listed below:

(i) International technology transfer is when technology is transferred across national boundaries. For instance, technology can be transferred from industrialised nations or economies to developing or emerging economies.

(ii) Regional technology transfer is when technology is transferred from one region of the country to another. For instance, from one state to another state within the same country.

(iii) Cross sector technology transfer (across industry) is when technology is transferred from one industrial sector to another. For instance, technology is transferred from agricultural activity to commercial activity.

(iv) Inter-firm technology transfer is when technology is transferred from one firm to another. For instance, the transfer of computer-aided manufacturing (CAM) machines is being transferred from a machine tool manufacturing firm to a furniture producing firm.

(v) Intra-firm technology transfer is when technology is transferred within a firm from one location to another. For instance, when technology from a particular company or firm in Abuja is transferred to another subsidiary in Suleja. It could also be from one department to another department that is within the same facility.

1.4.1 Stages of Technology Transfer Process

The transfer of technologies between countries especially from mostly developed countries to developing countries follows five different stages namely:

(i) The first stage includes sales and licensing agreements which covers all forms of industrial property such as patents, industrial design, trademarks, investors' certificates, service names and trade names, etc.

(ii) The second stage is the provision of technical expertise in the form of feasibility studies, diagrams, instructions, training, etc.

(iii) The third stage is the provision of basic engineering designs, installations and operations of acquired plants.

(iv) The fourth stage involves leases and acquiring of machinery, intermediate goods (raw materials) and equipment.

(v) The fifth stage involves industrial and technical cooperation agreements of any kind, international sub-contracting and provision of management and marketing services.

SELF ASSESMENT EXERCISE 2

i. Illustrate the stages through which technology can be transferred from a source to the receiver

1.5 Technology flow Channels to Developing Countries

Technology can flow easily across countries, industries, departments or individuals so long as there are established channels of flow. The two channels through which technologies can flow from the source to the receiver are informal and the formal flows.

Informal Flows of technological Transfer are:

i. General channels: - This is when technology is unintentionally transferred and may continue without the direct and continued involvement of the source. This could be in form of tourism, education, conferences and workshops, training as well as even publications.
ii. Reverse engineering: - This is when technology is transferred without going through the usual technology transfer process. It is mostly adopted by agencies and is the fastest route for duplicating an existing technology.

1.5.1 Formal Flows of Technological Transfer

This refers to the intentional transfer of technology from source to the receiver. It is also referred to as 'planned channels' because they follow a planned process so as to get the consent of the owner of the technology. The owner under different agreements then permits access to the receiver or user of the technology and they include:

i. Foreign direct investment (FDI) is where a multinational corporation decides to invest or produce its products overseas. This idea permits the transfer of technology to another country though the technology is still controlled by the firm. This type of investment becomes mutually beneficial to both the host economy and the investor. First, the host country gets technological knowhow, employment opportunities as well as training for the work force and investment capital that adds to the development of its infrastructure. The investor on the other hand gains access to natural resources, labour force, and markets for their products.

ii. Turn-key project is where a country (receiver) purchases a whole project from another country (source) and the project is designed, delivered and implemented ready to operate and use. There may

be special provisions for training or continued operational support but that will be determined by both parties. This may be equivalent to selling or buying the machine.

iii. Technical consortium on joint R&D project is where a country joins another country or more countries as a large venture, to affect the direction of technological change due to inadequate resources. Typically this type of venture takes place between two or more countries or two large conglomerates. All these cooperative projects aim to advance research, develop technology and transfer of knowledge to participating member states. Here, the entities combine their interests, share knowledge and resources to develop a technology or a product or use their know-how to complement one another.

iv. Licensing is when the receiver purchases the rights to utilize someone else's technology. It may involve a complete purchase or a payment of an initial lumpsum amount plus a percentage of sales.

v. Franchise is a form of licensing where the sources usually provides some type of continuous support to the receiver. This is a channel commonly used in developing countries by the industrialised nations when heavy technology is transferred. A few countries have encouraged joint ventures rather than FDI to maximize technology transfers to local firms. However, this strategy seems to work only for countries with substantial market power. In particular, fear of losing control over cutting-edge technologies sometimes causes multinational firms to be forced into joint ventures to reserve their best technologies for the domestic market and transfer only older less efficient ones.

SELF ASSESMENT EXERCISE 3

i. Identify the different flows of technological transfer.

ii. Explain the formal flows of technology transfer from source to the receiver.

1.6 Summary

From our discussion so far, we can deduce the following facts:

- That technology created in a particular economy can be transferred from its source to another source which is the receiver.

- That most times the developed countries are the sources of technology while the developing countries are the receivers.
- That technological transfer can be categorized into international technology transfer or domestic technology transfer involving regions, across sectors, inter firm and intra firm technology transfer.
- That the idea of transferring technology from the source to the receiver is a continuous process involving different stages.

In this unit, we discussed what is meant by technological transfer. We also identified the different categorisations of technological transfer. Technology transfer is not a one-off thing rather it continuously flows across regions, countries, companies, firms and departments within organisations and among individuals. Stages of technology transfer includes sales and licensing agreements, provision of technical expertise, provision of basic engineering designs, leasing of the technology and reaching of technical and industrial cooperation agreement between the source and the receivers. It is assumed that an understanding of this unit prepares the students for the next unit where technological diffusion and adoption will be discussed.

1.7 References/Further Readings

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1.8 Possible Answers to SAEs

Answers to SAEs 1

1. technology transfer is the process of transferring scientific findings, knowledge, manufacturing process, etc., from one organization to another for the purpose of developing them further as well as for commercial purposes.

Answers to SAEs 2

1. The first stage includes sales and licensing agreements which covers all forms of industrial property such as patents, industrial design, trademarks, investors' certificates, service names and trade names, etc.
2. The second stage is the provision of technical expertise in the form of feasibility studies, diagrams, instructions, training, etc.
3. The third stage is the provision of basic engineering designs, installations and operations of acquired plants.
4. The fourth stage involves leases and acquiring of machinery, intermediate goods (raw materials) and equipment.
5. The fifth stage involves industrial and technical cooperation agreements of any kind, international sub-contracting and provision of management and marketing services.

Answers to SAEs 3

Informal Flows of technological Transfer
Formal Flows of Technological Transfer

This refers to the intentional transfer of technology from source to the receiver. It is also referred to as 'planned channels' because they follow a planned process so as to get the consent of the owner of the technology.

Unit 2 Technology Diffusion And Adoption

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2.3.1 Definition and Explanation of Technology Diffusion and Adoption
2.4 Drivers of Technology Diffusion and Adoption
2.6 Summary
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2.8 Possible Answers to SAEs

2.1 Introduction

In the previous unit, we discussed technological transfer. In this unit, we will highlight issues on technological diffusion and adoption. The efficient diffusion of knowledge on new technologies is an essential characteristics of growth and development. New knowledge has no economic value until it has been used productively. This means that the more widely a particular bit of knowledge can be used, the greater its value becomes.

2.2 Learning Outcomes (Los)

At the end of this unit, student should be able to:

- Explain what is meant by technology diffusion and adoption
- Discuss the different drivers of technology diffusion and adoption.

2.3 Main Content

2.3.1 Definition and Explanation of Technology Diffusion and Adoption

Diffusion is the spread of knowledge from an original source or sources to one or more recipients. Technology diffusion does not follow a single uniform pattern. The process of diffusion tends to last the longest in the innovation center, that is, region of origin. Regions where diffusion begins later tends to have a quicker diffusion process as they “catch up” with the center of origin. The extent of diffusion within a region, the

adoption level, tends to be highest in the innovation center. Diffusion times are shorter in the "catch-up" regions and adoption levels are generally also lower. For instance, countries where automobiles and railways were first introduced, took nearly 100 years to reach maturity. Late adopters began several decades later, but diffusion took only a few decades instead of an entire century. The timing of diffusion also sets the pace for pervasive technological change, i.e., the emergence of the sort of technology clusters that determine global change. Important technology clusters needed several decades to develop initially, and about half a century to reach maturity in the innovation centers and to diffuse at the international level. Altogether, the overall temporal envelope of any particular technology cluster spans up to a century, with its main growth period covering about five decades.

1.4 Drivers of Technology Diffusion and Adoption

The achievement of technological progress in developing countries can be attributed to the ability of the economy to absorb and adapt pre-existing and new technologies, rather than to the invention of entirely new technologies. Given that technology gap exist in developing countries, this situation is likely bound to continue.

A developing country's ability to absorb and adopt foreign technologies depends on two main factors:

- The extent to which it is exposed to foreign technologies (the pace at which technologies diffuse across countries) and
- The ability to absorb and adapt those technologies to which it is exposed (the pace at which technology diffuses within the country).

The identified channels through which developing countries are exposed to foreign technologies so as to translate to technological achievements are:

a. International Trade - Trade is one of the most important mechanisms by which embodied technological knowledge (in the form of both capital and intermediate goods and services) is transferred across countries. Imports of technologically sophisticated goods help developing countries raise the quality of products as well as the efficiency with which they are produced. Countries can also absorb new technology by exporting to customers who provide guidance in meeting the specifications required for access to global markets. For developing countries with low R&D intensity, trade openness and exposure to foreign competition provide powerful inducements to adopt more advanced technology in both exporting and import-competing

firms and are likely to produce large technology spillovers and productivity gains (Schiff & Wang 2006).The dismantling of trade barriers in many developing countries increased developing countries' exposure to foreign technologies.

Participation in high-tech export markets has also been identified as a channel through which technology is diffused within developing countries. Exporting firms in developing countries benefit from technological transfers that occur as a result of their interactions with foreign buyers who may have higher quality standards than domestic buyers. These foreign buyers may also assist with information, process improvements and experience with foreign markets.

It should be noted that the extent to which imported technology boosts domestic technological activity either directly or indirectly depends on the quality of a country's technological absorptive capacity. Also, the business climate may be too weak or the technological literacy of the local labor force may be too low to successfully adapt the machinery to local conditions. The country may not realize the potential productivity improvements available from imported technology.

b. Foreign Direct Investment (FDI) - Like trade, FDI can be a powerful channel for the transmission of technology to developing countries by financing new investment in machinery and equipment purchases, by communicating information about technology to domestic affiliates of foreign firms, and by facilitating the diffusion of technology to local firms. Foreign Direct Investment (FDI) includes mergers and acquisitions that may involve no additional physical investment, and the share of mergers and acquisitions, including privatization transactions. Foreign firms may also improve the technological capacity of developing countries by financing R&D. Foreign direct investment (FDI) may also affect the level of technology in domestic firms. Spillovers can arise when workers receive training or accumulate experience working for multinationals and then move to domestic firms or set up their own enterprise. In addition, foreign investors may provide advice, designs, direct production assistance, or marketing contacts to suppliers, which the latter can then deploy more broadly than simply providing cheaper or more reliable inputs to the foreigners.

The entry of multinationals is likely to increase competition for the domestic firms within the industry, potentially forcing them to improve their efficiency and introduce new technologies or business strategies (Blomstrom, Kokko, & Zejan 2000). Such competition can make surviving domestic competitors stronger, but other domestic firms may

be driven out of business, lose market share, and experience a loss of high-skilled workers and higher costs for intermediate goods resulting from increasing demand from the foreign-owned firms. These effects may vary by industry depending on factors such as the market structure before the entry of foreign multinationals, the R&D intensity of the products, and the links between foreign firms and domestic firms in upstream and downstream sectors.

FDI is a major source of process technology and learning by doing opportunities for individuals in developing countries. In addition to dismantling barriers to foreign investment, some middle-income countries have encouraged greater FDI flows by implementing stronger regimes governing intellectual property rights.

c. International Migration - Substantial technology transfers are also associated with international migration of developing countries where the direction of technology transfer can be both outward (as migrants take away scarce skills) and inward (through contacts with the diaspora). Though not all of these are positive. The direction and scale of technology flows that result from international migration is not as clear as that of FDI and trade. Developing countries can benefit from the immigration of managers and engineers that often accompanies FDI, they can also benefit from the technologically sophistication of the returns of well-educated developing country emigrants.

High rates of skilled out-migration imply a net transfer of human capital and scarce resources (in the form of the cost of educating these workers) from low- to highincome countries. Most university-educated individuals from developing countries, these days do not return to or remain in their country of origin, leading to the problem of brain-drain. The issue of brain drain is a serious problem for a number of mostly small countries because the better educated citizens of developing countries working in high-income countries contribute to that economy. On the other hand, the contribution that these individuals would have made had they stayed home is uncertain given the lack of opportunities in their home countries.

However, the existence of a well-educated diaspora constitutes an important technological resource for the home country. For most countries, high-skilled outmigration remains at manageable levels and these knowledgeable Diasporas contribute to technology transfers by strengthening trade and investment linkages with more advanced economies through networks that provide access to technology, capital and through remittances. Remittances not only contribute to domestic entrepreneurship and investment, but also, along with the introduction of mobile phone services, have greatly expanded the provision of banking

and other financial services within developing countries. Finally, returning migrants can provide important resources, such as entrepreneurship, technology, marketing knowledge, and investment capital. The effect of a single returning émigré armed with skills acquired in a developed economy can have (and has had) large economic and technological effects on the country of origin.

d. Direct Government Policy: - Good governance and business environment should focus on strengthening the infrastructure necessary for the successful diffusion and implementation of technologies, on facilitating the diffusion of already existing technologies, and on developing domestic competencies. Developing countries in most cases do not have blueprint for technological progress, but most success stories have involved strong central leadership to ensure a consistent and effective policy framework that supports the development and commercialization of innovations.

e. Financing and Supporting Innovative Firms: - Developing is filled with more of informal sectors where technological progress is largely implemented by the private firms. However, progress at the firm level requires government support in form of an appropriate incentives framework, including overall political and economic stability and government transparency, along with specific technology policies such as protection of intellectual property rights; investments in human capital, including general education and technical training where firms underinvest in training because of the potential mobility of trained staff; support for R&D of new-to-the-market technologies because of difficulties in appropriating the full benefits from such efforts; and, where appropriate, government interventions to overcome market failures involving coordination, threshold effects, and agglomeration effects. Most technological success stories of countries such as Germany, Japan before and after World War II, the East Asian miracle countries, Chile, Ireland, and Israel have involved strong national leadership and a coherent strategy for promoting technology.

f. Basic Technological Literacy: - The capacity of firms or individuals to use a technology depends critically on the basic technological literacy as well as availability of skilled labour. The level of technological literacy, depends on the government's capacity to provide qualitative education health, and publiclyprovided infrastructure; in the procurement of goods and services; in the provision of information for the people.

2.6 Summary

In this unit, our emphasis is on technology diffusion and adoption, i.e., the widespread adoption of technologies over time, in space, and between different social strata. Understanding technology diffusion is very crucial because it is through diffusion that technologies exert noticeable impact on output and productivity growth, on socioeconomic development, and on the environment. Without diffusion, a new technology may be a triumph of human ingenuity, but it will not be an agent of global change. Technology diffusion in developing countries depends both on access to foreign technology (through trade, FDI, international migration, and other networks). The most important determinants of the absorptive capacity are the governance variables, human capital variables, financial intermediation and good macroeconomic environment.

Openness to external technologies through foreign trade, FDI, migration and other international networks is critical for technological progress of developing economies. Among developing economies, most progress occurs through the adoption, adaptation, and assimilation of pre-existing and new technologies. The preeminent vehicles for the dissemination and diffusion of technology in a market economy are the entrepreneurs whose success depends on their ability to undertake risk. Successful entrepreneurship requires a stable macroeconomic environment, together with a regulatory environment. The government can also have an important impact on economic progress by integrating new technologies into its own operations.

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2.8 Possible Answers to SAEs

Unit 3 Economic Theories Of Technology Change

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3.3.1 Exogenous growth theory
3.4 Endogenous growth theory
3.5 Theory of creative destruction
3.6 Summary
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3.8 Possible Answers to SAEs

3.1 Introduction

Traditional economists have viewed the relationship between technology and the economy as a one-way street. According to the neoclassical growth model of Solow (1956) and Swan (1956), shows how an economy reaches a steady state through the accumulation of capital. The steady state is where capital investment in each period is equal to depreciation. According to the endogenous growth theory technological change has a profound influence on our well-being indeed, the economy's long-run growth rate is determined exclusively by the rate of technological progress.

3.2 Learning Outcomes (Los)

At the end of this unit, you should be able to:

- explain the exogenous growth theory
- describe the endogenous growth theory
- discuss the theory of creative destruction

3.3 Main Content

3.3.1 Exogenous Growth Theory

The initial neoclassical theory was developed by Solow in 1956 and then augmented by other scholars. According to the theory, sustained economic growth occurs through an exogenous factor of production, that

is, the passage of time. It is represented by the Cobb Douglas production function which relates output to factor inputs (stock of accumulated physical capital and labour). The theory imposes decreasing returns with respect to the use of each (reproducible) factor of production (and constant returns overall). The assumption shows that an increase in the stock of capital goods will result in a less than proportionate increase in output, if labour remains constant. Eventually more capital stock will produce no more output, resulting in lower profits and low output.

The neoclassical model states that in the long term, the growth rate of output per worker is dependent on the rate of labour-augmenting improvement in technology, which is determined by exogenous factor(s) not contained in the model. The model implies that all economies using similar technology will eventually converge to a stead state of growth.

Though Solow remarked that "the steady state is not a bad place for the theory of growth to start, but may be a dangerous place for it to end".

The Cobb-Douglas production function also known as the neoclassical production function, is expressed as follows:

$$Y = L^{\alpha}K^{\beta}\,T \qquad \text{where } \alpha + \beta = 1 \qquad (1)$$

where: Y= output; L= labour; K= capital; T= time or the rate of technological progress which changes over time. The weights α *and* β represent the proportion of Y that accrues to labour *(L)* and capital *(K)* respectively.

A simple Solow model depicts the output, Y, of a business, as a function of three variables: capital, K, labour, L, and knowledge, A_t

$$Y = K^{\alpha}(A_tL)^{\,1-\alpha} \qquad 0 < \alpha < 1 \qquad (2)$$

Knowledge or technical progress is assumed to be independent of both the capital and labour inputs and to be a nonrival good, which is free for all businesses. It appears multiplicatively with labour in (1), denoting that knowledge contributes by "augmenting" labour and not affecting capital. The exponents α and $1-\alpha$ measure the relative contribution of the two inputs of capital and "effective labour". These exponents add to unity, to comply with the constant-returns-to-scale assumption for production.
According to Solow, the differences in productivity levels may be caused by faster/slower population growth or a higher/lower savings rate, while lower productivity could be due to climate deficiencies or other factors not accounted for in the model.

This model has two important features which recent growth theories have challenged:

- If people were to save a constant proportion of their income, capital per effective worker would be constant in the long run, so that $k' = 0$ and per capita income growth is therefore entirely determined by knowledge growth, α.
- Increasing the savings (i.e. investment) ratio could raise an economy's income level (permanently) by raising the growth rate of capital (and income) in the short run, but since the ratio of savings to income cannot continue to increase indefinitely, investment cannot cause income to grow permanently. Countries that invest more would be wealthier but would not grow faster since the only source of long-term growth is technical progress (or "knowledge accumulation"), which is assumed to occur at an exogenous rate. According to this model, income growth rates are beyond business and government control, but, reallife experiences point to the contrary.

SELF ASSESMENT EXERCISE 1

i. Explain the exogenous growth theory

3.4 Endogenous Growth Theory

The endogenous growth theory which was developed by Romer (1986) and Lucas (1988), shows that conventional economics can be used to analyze the two-way relationship between technology and economics as well as the feedback effect from the economy to technological change. Technological progress is another form of capital accumulation because it consists of the accumulation of knowledge, in form of intellectual capital, much like physical or human capital. Technological knowledge, like other forms of capital, can be accumulated with the expenditure of current economic resources (R&D expenditures) and can be used to augment future production possibilities. In this theory, technological progress, like capital accumulation, arises from decisions to save. Some saving goes to finance the accumulation of physical and human capital, and some goes to finance the R&D that causes technological knowledge to accumulate. Thus, if the society saves a larger part of their national income, it leads to economic growth through increase of technological progress.

The new growth theory brought the endogenous technological change into the mainstream of economics and revived interest in long-term economic growth as an objective of economic policy. The old theory presented a negative view of what economic policy could do in this

regard, arguing that, in the long run, economic growth is limited by progress in physics, biology, and engineering, rather than by economic forces. But the new growth theory says that an economy's long-run growth rate depends on people's willingness to save, which is very much affected by economic policy. Moreover, standard cost-benefit analysis shows that a policy that produces even a tiny increase in long-term economic growth can generate benefits whose discounted present value are enormous.

In the traditional endogenous growth theory, economic growth is likened to a private activity where economies can save to become richer just like private individuals. This simple theory will guide the developing countries in analyzing government policies that will affect national saving even though it ignores a critical social aspect of the growth process by being viewed as something that will raise everyone's standard of living. This new theory emphasizes the distinction between technological knowledge and capital, and analyzes the process of technological innovation as a separate activity from saving. The new wave is explicit about who gains from technological progress, who loses, how the gains and losses depend on social arrangements, and how such arrangements affect society's willingness and ability to create and cope with technological change.

SELF ASSESMENT EXERCISE 2

i. Describe the endogenous growth theory.

3.5 The Theory of Creative Destruction

One aspect of the endogenous growth theory was developed by Schumpeter, a development economist. The theory is called the *theory of creative destruction* because it involves a situation where each innovation produces new technological knowledge that improves our material possibilities and renders obsolete some of the technological knowledge that were originally created by previous innovations. Schumpeterian theory analyzes the process of technological innovation as being separate from saving. It highlights the difference between capital and technological knowledge. It sees economic growth as a social process bound up with institutions, policies, social customs, and many other phenomena that affect not only the incentive to save but also the incentive to create new knowledge and the willingness to adapt to change.

The theory of creative destruction holds that it is innovation rather price that determines firms competition (Howett, 2007). It explains that the

gains and losses of technological progress depend on social arrangements, and how such arrangements affect society's ability to create and cope with technological change. By this, the theory offers a new perspective on a number of important economic issues that interact with economic growth. Technically, a model of growth through creative destruction can be seen in terms of two long run relationships, that is, between the rate of economic growth (the growth rate of GDP per worker) and the amount of capital per efficiency unit of labour (efficiency units is measured by hours worked multiplied by productivity). An increase in the saving rate would resulting in a higher steady-state capital stock per efficiency unit for any given longrun growth rate. A higher rate of growth would imply a faster rate of technological progress, and hence a faster-growing labour force measured in efficiency units. The economy-wide level of R&D determines the flow of innovations, which, in turn, governs the rate of technological progress and, therefore, the long-run rate of economic growth. Given the constant institutional and policy variables, an increase in the steady-state capital stock per efficiency unit of labour raises the incentive to perform R&D through a "scale effect." That is, more capital per worker results in more production per worker, and hence more income per person, for any given level of technology (see Howitt and Aghion 1998). And when people have larger incomes, they spend more on newly invented products, which raises the incentive to perform R&D, and results in a faster rate of economic growth. Likewise, any changes in institutions, policies, or other variables that affect the incentive to perform R&D results in different rates of R&D and of long-run growth for any given capital stock per effective worker. According to this theory, the long-run growth rate is determined by strengthening the incentive to perform R&D and raising the economy's propensity to save.

SELF ASSESMENT EXERCISE 3

i. What do you understand by the theory of creative destruction?

3.6 Summary

In this unit we may conclude that the new theory leads to several broad conclusions that are relevant for current policy debates. Also relevant is the fact that competition policy should not be relaxed in the hope of boosting innovation. This is because more competition actually strengthens the incentive to innovate. Any economy that engages in R&D increases the flow of innovations in the economy, which, in turn, governs

the rate of technological progress and, therefore, the long-run rate of economic growth.

The mainstream growth theory believes that technological progress in the form of new products, new ideas, new markets and new techniques due not emanate from the scientific laboratory but come from discoveries made by private profit-seeking business enterprises. The new growth theories such as endogenous growth theory posit that technological progress is accumulation of knowledge, which is a form of intellectual capital. This intellectual knowledge can be accumulated by spending on R&D and can be used to augment future production possibilities. Schumpeterian creative destruction theory offers new view of how competitive markets work by being motivated by innovations.

3.7 References/Further Readings

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3.8 Possible Answers to SAEs

Answers to SAEs 1

1. The theory imposes decreasing returns with respect to the use of each (reproducible) factor of production (and constant returns overall).

Answers to SAEs 2

1. The endogenous growth theory which was developed by Romer (1986) and Lucas (1988), shows that conventional economics can be used to analyze the two-way relationship between technology and economics as well as the feedback effect from the economy to technological change.

Answers to SAEs 3

1. The theory is called the theory of creative destruction because it involves a situation where each innovation produces new technological knowledge that improves our material possibilities and renders obsolete some of the technological knowledge that were originally created by previous innovations.

Unit 4 Issues Of Technology Acquisition In Developing Countries

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4.1 Introduction

The problem of technology transfer is related to certain issues which includes technology acquisition and the choice of appropriate technology. Technological development comes from R&D, from international organizations, etc. whatever be the case, every available sources needs to be explored when acquiring new technologies. The technology adoption model explains how accessibility and exposure play a role in technology adoption.

4.2 Learning Outcomes (Los)

At the end of this unit, student should be able to:

- Explain the different modes of technology acquisition
- Discus the challenges of technological acquisition in developing countries
- Ilustrate the strategies to technology adoption in developing countries

4.3 Main Content

4.3.1 Technology Acquisition

One of the major issues in technology relates to the mode of technology acquisition. Developing new technology may come from different sources such as works of scientists, manufacturers and other industries, universities researchers who are working in R& D laboratories, governments and multinational corporations. Whatever may be the case, every source needs to be explored for ideas and new technologies. Each firm has specific sources for most of the new technologies. The question then should be how will the firm acquire new technology, is it going to be a "make or buy decision". In other words, should the firm develop the technology itself or acquire it from an outside source? The decision should be taken very carefully at this stage.

The acquisition routes of three stages are: (i) Internal (ii) External and (iii) Combined sources.

i. Internal technology acquisition through in-house creation - This is the result of technology development efforts that are initiated and controlled by the firm itself. Internal acquisition requires the existence of a technological capability in the company. Internal technology acquisition options have the advantage any innovation becomes the exclusive property of the firm.
ii. External technology acquisition- External acquisition is the process of acquiring technologies developed by others for use in the company. External technology acquisition generally has the advantage of reduced cost and time to implement and lower risks. However, the technology available from outside sources is generally developed for different applications. Therefore, external acquisition should contain an aspect of adaptation to the acquiring company's application.
iii. Combined sources – This is when technology acquisition involves a combination of both external and internal activities. The essence of using a combined acquisition is to take advantages of both internal and external sources and at the same time overcome the limitations of both.

4.4.2 Choice of Technology

The second major issue related to technology transfer is the choice of technology. It is argued that it is the industrialized countries that develop technology and know- how, thus whatever that is developed will be mainly useful to them making them become monopolists in developing, using and managing technology. This also means that the technologies tend to be designed for the production of high quality sophisticated goods on a large scale, using as much as possible capital and higher level

professional skills in place of sheer. In carrying out technology transfer from developed countries to developing countries, care needs to be taken because if the technology content and level are not appropriate, the technology will be more harmful than good.

Such "appropriate technology" raises several questions for the international/national managers, that is, to what extent or feasible alternative technologies are readily available? If not available, can the cost of developing more appropriate technology be justified? The issue of cost of the technology transfer is a very serious issue for developing countries. For instance, 90% of the modern technology transfers to developing countries is controlled by multinational corporations who are essentially interested in getting the highest returns from their inventions. Even, the developing countries reacted in their own way to face the restrictive clauses imposed by international business on their exports of technologies.

4.4.3 Creating Local Capability

Technology is not simply a blue prints that can be transferred to any part of the world without the receiver putting any local effort. Creating local technological capability is essential to absorb imported technology. Each time some technology is installed some local adoption is required, which demands local technological capability. The need for local adaptation arises from the fact that the environment in which any technology operates is unique in a situation when it is installed. Difficulties are often found in the availability of skilled labour, the dexterity, training, education and experience, availability and quality of materials and components and infrastructural facilities including energy, transportation, water and communication. The local technological capabilities are also needed in order to adopt technologies to local conditions to improve productivity in the operations and to permit the attainment of international competitiveness and growth of exports.

SELF ASSESMENT EXERCISE 1

i. What is technology adoption?

ii. Discuss what determines the choice of technology adoption in developing countries.

4.4 Technology Acceptance Model (TAM)

Research on technology adoption and diffusion in developing countries focus mostly in Information and Communication Technology and they assume that technology is readily available, with the receiver or user deciding whether to accept or reject the technology (Musa, Meso & Mbarika, 2005). This assumption may not hold water because the developing regions such as sub-Saharan Africa lag behind in basic socioeconomic factors when compared to other regions of the world. Meanwhile these factors are very important for the day-to-day use of modern technologies (Meso & Mbarika, 2005). Therefore, to the users of ICT, adoption is not a matter of choice, since universal access and exposure to technology is not available. Access and exposure to basic forms of technology over a period of time gives room for application of a more advanced types of technologies to aid in human development efforts. Technologies adoption requires that economies should take into consideration their cultural, historical and socioeconomic conditions at all times before acquiring the technology.

Gallivan, (2001) posit that some theories such as the theory of planned behavior, diffusion of innovations, social cognitive theory, and the technology acceptance model have been used to explain technology adoption and acceptance. One of the most referenced of these models is the Technology Acceptance Model (TAM) which suggests that successful adoption (acceptance) of technology is dependent on its usefulness and its ease-of-use (Davis, et al.,1989).

Technology Acceptance Model (TAM) was developed from the theory of planned behavior (TPB), of psychology research which centres on the theory of reasoned action (Mathieson, et al., 2001). TAM was is different from the theory of planned behavior because it studies decision-making processes of users whether to adopt information technology or not. Despite the usefulness and practicability of TAM, the original model is limited when it comes to developing economies due to the inadequacy of technology on developing countries. Musa et al (2005) developed a more appropriate model for developing countries starting with perceived user resource model (PUR) proposed by Mathieson, et al. (2001).

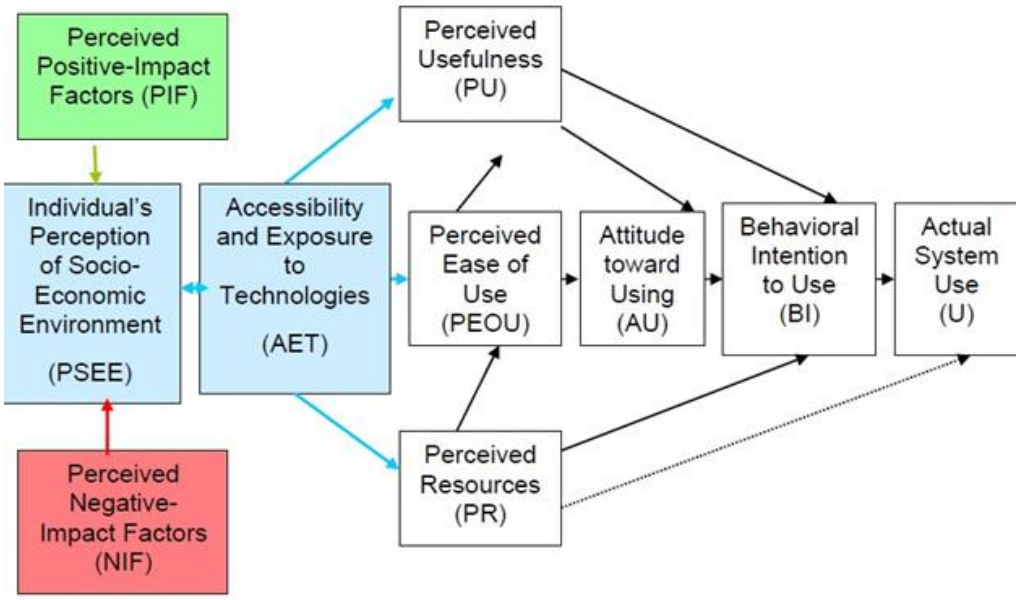

Figure 8: The Revised TAM: Merging TAM with Socio-Economic Development. Source: Musa, Meso and Mbarika (2005)

The model shown in Figure 8 incorporates the linkages between factors of socioeconomic development and technological infrastructure (as captured by accessibility to technology). The model also captures the individual's perception of both positive and negative impact factors. The positive impact factors are factors that propels a nation towards making fundamental improvements in its socio-economic development[1], while the negative impact factors constitute major impediments to socio-economic development. The perceived user resources are designated by "PR", which is the extent to which an individual believes that the personal and organizational resources needed to use an Information System are available. The perceived user resources include factors such as skills, human assistance, hardware, software, time, documentation, and money [Mathieson, et al., 2001].

The new model provides the dynamics between socioeconomic development as measured by human development indices and technology adoption that would further aid in national (human) development efforts. The "Accessibility and Exposure to Technologies" as shown in Figure 8 refers to the technology that is in place and available for use. These technologies include related ICTs such as internets, computers, telecommunications networks and any other form of technology in a user's world.

[1] Such as health, democracy, good governance, economic productivity, social well-being, the physical environment, roads, water and power supply, education, employment, and pressure or desire to integrate into the world economy, etc.

The factors labeled "Perceived Positive-Impact Factors" and "Perceived Negative- Impact Factors" impact the "Individual's Perception of Socioeconomic Environment" (Musa, et al 2005). The extension of the perceived user resource model points out the importance of accessibility and exposure to technologies adoption and how the various factors in technology adoption and socioeconomic development interact with each other. Adequate technology adoption allows a country to realize the impact of technology. It is the impact of ICTs that is of most importance. According to Sein and Harindranath, (2004) as cited in Musa et al (2005), research on ICT impacts posits three levels or effects:

i. First-Order or primary effects where simple old technology is substituted by old technologies. For example, access and ability to use a tractor alleviates the backbreaking hoe and hand-digger method of tilling the land. Another example is when telecommunication technologies provide faster alternatives to traditional means of communication (snail-mail). While realizing the primary effects does not generally imply development, it paves the way for higher order effects to take place.
ii. Second-Order or secondary effects where a phenomenon such as technologyenabled correspondence takes on a larger meaning, such as sharing of documents or graphics. For example, this effect aids in co-authoring of research across vast geographical areas.
iii. Third-Order or tertiary effects; the generation of new technology-related businesses and societal change. For example, the introduction of communication technology should spur the development of new businesses, for example electronic communication-enabled media such as virtual organizations.

We suggest that sustainable economic and human development would call for a systematic progression and maturation through these three effects. The proliferation of telecommunications in developed countries came as a result of the need for basic necessities of life are met, hence developing countries should learn a valuable lesson from that.

4.4.1 Barriers to Technology Acqusition in Developing Countries

The barriers and challallenges encountered in acquisition of technology are:

(i) Poor planning in developing countries which invariable affects the process of receiving the new technology.
(ii) Limited understanding of the technology concept as it relates to the issues of installing and maintenance.
(iii) Failure of recognisation of local potentials for adopting new technology

(iv) Failure to determine the possible applications of the transferred technology
(v) Presence of ethical issues witin the process of technology transfer
(vi) Restricting the feasibility study of technology transfer to just financing assessment without evaluating the local potential adoption.

4.5 Strategies to Improving Technology Acquisition in Developing Countries

A host economy can adopt the following strategies relating to technology transfer.

(i) The host economy needs to be strong and vibrant so as to be able to absorb technology.
(ii) There should be policies directed towards importing of technology, for instance, government can discourage restrictive clauses partaining to technology transfer. The policy can influence the terms and conditions of technology transfer.
(iii) Government should be able to encourage indigenous knowledge through domestic R&D.
(iv) Countries can encourage and promote cross boarder collaborative R&D
(v) Encourage indegeous production of technology by developing state owned enterprises.
(vi) Encourage development of state owned enterprises.
(vii) Liberalized terms of technology transfer and diffusion that would benefit both parties.
(viii) Encourage indigenous production of technology subsequent to transfer of technology.

4.6 Summary

In this unit, we can conclude that technology continuously flows across boundaries of countries, regions, companies and departments within organizations and among individuals. The transfer of technology from one entity to another is affected through channels of technology flow. There may be general channels of contact among individuals and institutions or organized programs designed for the systematic transfer of technology. Effective and efficient technology transfer requires the formulation of a strategy and the creation of mechanisms of transfer. These mechanisms can be technology transfer centres, information exchange networks or organized projects that utilize special teams to affect the transfer.

In this unit, we discussed the challenges of technological transfer in developing countries and the strategies to technology transfer. Technology is not a blue print issue that can be acquired without creating local technological capability which is essential to absorb imported technology. Technology can be acquired through internal sources, external sources or a combination of both. For technology to be acquired from developed countries, governments of developing countries needs to encourage collaborations and also encourage R&D. Indigenous technology should also be encouraged in developing countries. The TAM suggest that with systematic and incremental approach to development, developing countries would be able to catch up with the rest of the world in a reasonable time frame.

4.7 References/Further Readings

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4.8 Possible Answers to SAEs