NATIONAL OPEN UNIVERSITY OF NIGERIA

SCHOOL OF EDUCATION

COURSE CODE : EDP 801

COURSE TITLE : ANALYTICAL APPROACH TO EDUCATIONAL PLANNING

EDP 801: ANALYTICAL APPROACH TO EDUCATIONAL PLANNING

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INTRODUCTION

EDP 801: Analytical Approach to Educational Planning is a first semester year one, two credit, and 800 level Core Course. It will be available for all students offering M.Ed Educational Planning. It will also be suitable as "One-of" course for anyone who does not intend to complete a National Open University of Nigeria (NOUN) qualification, but wants to learn about the Concepts, models and theories of Educational Planning.

This course will expose you to an understanding of many of the concepts, theories and models in Educational Planning. It will assist you to be able to apply these models to the tasks, roles and decision making process that Educational stakeholders perform in the Educational sector.

The course will consist of 21 units which includes Course Guide, definition of Educational Planning, Models, Structural and Behavioural approach to Educational Planning, definition of Planning, Educational Planning as a concept, Elements of Planning, Roles of Models in Educational Planning, Principles of Model Design, Uses of Models, Linear programming, Assignment Model, Transportation Model, Planning Model, Breakeven Analysis, Lowry Model, Forecasting techniques, Optimization Models, Decision Theory Model and their applications to Educational Planning in Nigeria.

This Course Guide tells you briefly what the course is about, what course materials you will be using and how you can work your way through these e general guidelines for the amount of time you are likely to spend on each unit of the course in order to complete it successfully.

It also gives you some guidance on your tutor-marked assignments, which will be made available in the assignment file. There are regular tutorial classes that are linked to the course. You are advised to attend these sessions.

WHAT YOU WILL LEARN IN THIS COURSE

The overall aim of EDP 801: Analytical Approach to Educational Planning is to introduce Educational Planning Models and acquaint you with the important concepts in Educational Planning. The context in which Planning and Modelling are being practiced and structured will also be explained. The Educational sector which forms the foundation of development at all levels will be examined, the types of model building, phases of Educational Planning model, standard form of linear programming, Mathematical statement of the problem, concepts to consider for the breakeven point, forecasting and predictions and the optimization level of model. The developments of these concepts later found relevance in the area of Education especially planning..

The understanding of these Concepts and development and application of theses in Educational planning is vital because it serves as a framework for the practice of planning and development of policies and decision making for educational programmes and other school activities especially in the attainment of Educational objectives. From time to time the Educational Administrators need to make decisions, which will interpret the policies and onal system in the country. During this course, you will learn about the development of appropriate models for planning in school (institution) to ensure the most effective and efficient way of getting Educational decisions done.

The course will also expose you to an understanding of the concept of planning individually and collectively in the Educational sector, the various approaches to educational planning such as social demand approach, manpower approach, and cost-benefit approach. These are approaches that are applicable to educational planning worldwide through the design of appropriate models both for qualitative and quantitative analysis. Specific reference will be made to the relevance of these approaches for meaningful educational development.

You will also learn the methodologies of planning education. The actual process of planning within the Nigerian context will be broadly spelt out though the use of appropriate models for each sub-section in the education sector.

This course will also refresh your knowledge on operational research and analysis of Education in Nigeria, the management and control of education. Finally you will learn to examine the educational problems, issues, tasks and challenges that are ahead of future Educational system.

COURSE AIMS

This course aims at defining and redefining your understanding of modelling in educational planning. The approach to model building, underlying ess and it practice will help in the instrument like decision making, structuring of the teaching-learning and control of all the resources in the sector. The structure in which all these educational stakeholders functions will be fine tune. This will be achieved by aiming to:

- Introduce you to the definition and meaning of the concept of Model building.
- Describe the structural and behavioural approach to Model building.
- Outline the methods and tools employed, in decision making in the education sector.
- Explain the practice of educational planning in the establishment of the structural, infrastructural and instructional facilities.
- Describe the concept of Educational Planning and its techniques and methodologies.
- Outline the main constraint in Model building in the process of Educational Planning.
- Explain the breakeven point, forecasting and techniques, optimization level of educational theory models.

COURSE OBJECTIVE

To achieve the aims set out, the course sets overall objectives. Each unit also has specific objectives. The unit objectives are always included at the beginning of a unit; you should read them before you start working through the r to them during your study of the unit to check on your progress.

You should always look at the unit objectives after completing a unit. In doing so you will be sure that you have followed the instructions in the unit.

Below are the wider objectives of the course as a whole. By meeting these objectives you should have achieved the aims of the course as a whole.

On successful completion of the course you should be able to:

1. Define the concept of Model.
2. Discuss the structural approach in model building.
3. Discuss the behavioural approach in model building.
4. Explain Planning as a concept.
5. Specify the importance of each model of educational planning.
6. Discuss the elements in Educational planning.
7. Specify the principles of designing a model
8. Describe the Linear programming problem.
9. Describe the Assignment Model.
10. Describe the Transportation Models.
11. Describe the Planning Models
12. Describe the breakeven Analysis.
13. Describe the forecasting technique.
14. Explain the Lowry Model
15. Attribute models in terms of the areas of need.

ssible constraints in the development and implementation of the models in educational planning.

17. Determine the state at which transportation model becomes unbalance situation.

18. Discuss long and short time planning in forecasting technique.

19. Apply decision theory model in the planning process of the educational system.

20. Analyse educational problems based on the use of appropriate model.

WORKING THROUGH THIS COURSE

To complete this course you are required to read the study units, read set books and read other materials provided by the National Open University of Nigeria (NOUN). Each unit contains self-assessment exercises, and at points in the course you are required to submit assignments for assessment purposes. At the end of the course, there is a final examination. The course should take you about 17 weeks in total to complete. You will find listed below all the components of the course, what you have to do and how you should allocate your time to each unit in order to complete the course successfully on time.

COURSE MATERIALS

Major components of the course are:

- Study Units
- References
- Assignment file
- Presentation Schedule

STUDY UNITS

The study units in this course are as follows:

Course Guide

Module 1; App roaches in model building

Unit 1: Structuralist approaches in model building

Unit 2: Behaviouralist approaches in model building

Unit 3: Planning as a concept

Unit 4: Educational planning as a concept

Unit 5: Important element in planning

Module 2 Models and Educational planning

Unit 6: Roles of model in Educational Planning

Unit 7: Principle of design of Model

Unit 8: Uses of models

Unit 9: Linear programming problem 1

Unit 10: Linear programming problem 2

Module 3 Types of Eduacational models

Unit 11: Assignment Model

Unit 12: Transportation Model

Model 2

Unit 14: Transportation Model 3

Unit 15: Transportation Model 4

Unit 16: Planning Model

Module 4 ;Other Types of Educational models

Unit 17: Breakeven Analysis

Unit 18: Lowry Model

Unit 19: Forecasting Techniques

Unit 20: Optimization Model

Unit 21: Decision Theory Model

The first two units analysed the view of structuralist and behaviouralist approaches in educational model building. The next four units are basically on planning. These are spread to the concept of planning, Educational planning, element of planning and the roles of model educational planning. The next two units emphase on the principles of design of model and its uses are explained. The next two units give linear programming problems: linear formation and the graphical methods applicable to educational Personnel and Educational Management Scientist.

The next unit explains the assumptions, mathematical statement of the problem and the Hungarian method.

The Transportation Model constitutes the next four units where the North-East method or rule, Vogel Approximation method and unbalanced re discussed in the concept of planning, the approaches, the process and the models for Educational Planning. The next is the planning model. Unit 17, however is based on the breakeven analysis where the assumption are also put into consideration. The last four units explain the applicability of the Lowry model, forecasting techniques, optimization model and the decision model and their application to educational planning in the educational system of Nigeria. In addition, the task, challenges and classification of these concepts ahead of future Educational Planning in Nigeria cannot be over emphased.

Each study unit consists of one to two weeks work, and includes introduction objectives, reading material, exercise, conclusion, summary, tutor-marked assignments (TMAs) and marking scheme, references, further reading and other resources. The units direct your work on exercises related to the required readings. In general, this exercise questions you on the material you have just covered or requires you to apply it in some way and, thereby, help you to gauge your progress and then reinforce your understanding of the material. Together with tutor-marked assignments, these exercises will assist you in achieving the stated learning objectives of the individual units and of the course.

ASSIGNMENT FILE

There are assignments in this course. The course assignments will cover –

behaviouralist views on Educational Planning in model building (Course Guide Units 1 and 2).

(2) The development of Educational Planning models with the appropriate uses (Units 3 – 8).

(3) The application of Linear programming in Educational planning model (Course Guide Unit 9-10).

(4) The application of Assignment model in Educational planning model (Course Guide Unit 11)

(5) The application of Transportation Model in Educational planning model (Course Guide Unit 11-15)

(6) An understanding of the Planning model (Course Guide Unit 16)

(7) An analysis of the Break-even point. (Course Guide Unit 17)

(8) An understanding of the concept of Lowry Model. (Course Guide Unit 18)

(9) An understanding of the concept of Forecasting Techniques. (Course Guide Unit 19)

(10) Determination of the optimization Model. (Course Guide Unit 20)

(11) The application of decision theory model to a given educational problem (Course Guide Unit 21).

PRESENTATION SCHEDULE

The presentation schedule included in your course materials gives you the important dates for the completion of tutor-marked assignments and member, you are required to submit all your assignments by the due date. You should guard against falling behind in your work.

ASSESSMENT

There are three aspects to the assessment of the course: first are self-exercises, second are the tutor-marked assignments; and third, there is a written examination.

In tackling the assignments, you are advised to be sincere in attempting the exercises; you are expected to apply information, knowledge and techniques gathered during the course. The assignments must be submitted to your tutor for formal assessment in accordance with the deadlines stated in the **Presentation Schedule** and the **Assignment file**. The work you submit to your tutor for assessment will count for 50% of your total course mark.

At the end of the course, you will need to sit for a final written examination of 'three hours' duration. This examination will also count for 50% of your total course mark.

TUTOR-MARKED ASSIGNMENT (TMAs)

There are eleven tutor-marked assignments in this course. You only need to submit ten of the eleven assignments. You are encouraged, however, to nts in which case the highest eight of the ten marks will be counted. Each assignment counts 10% towards your total course mark.

Assignment questions for the units in this course are contained in the **Assignment File**. You will be able to complete your assignment from the information and materials contained in your reading, references and study units. However, it is desirable to demonstrate that you have read and researched more widely than the required minimum. Using other references will give you a broader viewpoint and may provide a deeper understanding of the subject.

When you have completed each assignment, send it together with a TMA (tutor-marked assignment) form, to your tutor. Make sure that each assignment reaches your tutor on or before the deadline given in the **Presentation Schedule** and **Assignment file**. If for any reason, you cannot complete your work on time, contact your tutor before the assignment is due to discuss the possibility of an extension. Extensions will not be granted after the due date unless there are exceptional circumstances.

FINAL EXAMINATION AND GRADING

The final examination for EDP 801 will be of three hours' duration and have a value of 50% of the total course grade. The examination will consist of questions, which reflect the types of self-testing, practice exercise and tutor-marked problems you have previously encountered. All areas of the course will be assessed.

the time between finishing the last unit and sitting for the examination to revise the entire course. You might find it useful to review self-tests tutor-marked assignments and comments on them before the examination. The final examination covers information from all parts of the Course.

COURSE MARKING SC HEME

ASSESSMENT	MARKS
Assignment 1 – 11	Ten assignments, best eight marks of the ten count @ 10% each = 50% of course marks
Final Examination	50% of overall course marks
TOTAL	**100% of course marks**

Total 1 Course Marking Scheme.

COURSE OVERVIEW

This table brings together the units, the number of weeks you should take to complete them, and the assignments that follow them.

Unit	Title of work	Weeks activity	Assessment (end of unit)
1	Structuralist approaches in model building	1	
2	Behaviouralist approaches in model building	1	Assignment 1
3	Planning as a concept	1	

	g as a concept	1	
5	Important element in planning	1	
6	Roles of model in Educational Planning	1	
7	Principle of design of Model	1	
8	Uses of models	1	Assignment 2
9	Linear programming problem 1	1	
10	Linear programming problem 2	1	Assignment 3
11	Assignment Model	1	Assignment 4
12	Transportation Model	1	
13	Transportation Model 2	1	
14	Transportation Model 3	1	
15	Transportation Model 4	1	Assignment 5
16	Planning Model	1	Assignment 6
17	Breakeven Analysis	1	Assignment 7
18	Lowry Model	1	Assignment 8
19	Forecasting Techniques	1	Assignment 9
20	Optimization Model	1	Assignment 10
21	Decision Theory Model	1	Assignment 11

HOW TO GET THE MOST FROM THIS CO URSE

In distance learning, the study units replace the university lecturer. This is one of the great advantages of distant learning. You can read and work through specially designed study materials at your own pace, and at a time est. Think of it as reading the lecture instead of listening to a lecturer. In the same way that a lecturer might set you some reading to do, the study unit will tell you when to read your materials. Just as a lecturer might give you an in-class exercise, your study units provide exercises for you to do at appropriate points.

Each of the study units follows 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. You should use these objectives to guide your study. 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 significantly improve your chances of passing the course.

The main body of the unit guides you through the required reading from other sources. This will usually be either from a **Reading Section** of some other sources.

Self-test are interspersed throughout the end of 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 self-test as you come to it in the study unit.

There will also be numerous examples given in the study units. Work through these when you come to them too.

actical strategy for working through the course. If you run into any trouble, telephone 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 will be made available. You need to gather all this information in one place, such as your diary or a wall calendar. Whatever method you choose to use, you should decide on and write in your own dates for working on 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 for 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

the study unit you are working on and one of your references, 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 units, you will be instructed to read sections from your other sources. Use the unit to guide your reading.

(7) Well before the relevant due date, check your Assignment File and make sure you attend to 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 examination. Submit all assignments not later than the due date.

(8) Reviewing the objectives for each study unit confirms that you have achieved them. If you feel unsure about any of the objectives, review the study material or consult your tutor.

(9) 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 face your study so that you keep yourself on schedule.

(10) When you have submitted an assignment to your tutor for marking do not wait for its return before starting on the next unit. Keep to your Schedule. When the assignment is returned, pay particular attention to your tutor's comments, both on the tutor-marked assignment form

...n the assignment. Consult your tutor as soon as possible if you have any questions or problems.

(11) 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 the Course Guide)

TUTORS AND TUTORIALS

There are 22 hours of tutorials provided in support of this course. You will be notified of the dates, time and location of these tutorials, together with the names and phone number of your tutor, as soon as you are allocated a tutorial group.

Your tutor will mark and comment on your assignments, keep a close watch on your progress and on any difficulties you might encounter and provide assistance to you during the course. You must mail your tutor-marked assignments to your tutor well before the due date (at least two working days are required). They will be marked by your tutor and returned to you as soon as possible. Do not hesitate to contact your tutor by telephone, e-mail, or discussion board if you need help. The following might be circumstances in which you would find help necessary.

Contact your tutor if:

- You do not understand any part of the study units or the assigned readings.

th the self-test or exercise.

- You have a question or problem with an assignment with your tutor's comment on an assignment or with the grading of an assignment.

You should try your best to attend the tutorials. This is the only chance to have face to face contact with your tutor and to ask questions which are answered instantly. You can raise any problem encountered in the course of your study. To gain the maximum benefit from course tutorials prepare a question list before attending them. You will learn a lot from participating in discussions actively.

SUMMARY

EDP 801 intends to introduce you the analytical approaches to model building in Educational Planning. Upon completing this course, you will be equipped with the basic knowledge of developing appropriate models in the planning of the Education of a country like Nigeria, importance of models to Educational Planners and the various ways which model can take in the Educational sector. You will be able to answer these kinds of questions:

- What is a Model?
- Who is an Educational Planner?
- How will you describe the Structuralist Approach in Model building as applicable to Educational Planning?
- How will you describe the Behaviouralist Approach in Model building as applicable to Educational Planning?
- What are the concepts behind Educational Planning?

dels in line with the principles?

- Why do we make use of Models in Educational Planning?
- State the assumption underlining the application of the following:
  - Linear Programming Problem
  - Assignment Model
  - Transportation Model
  - Break-even Point Analysis
  - Lowry Model
  - Optimization Model
  - Decision Theory Model
- How do we apply these Models in Educational Planning?
- What impact does Forecasting Techniques have on Educational Planning?

Of course the list of questions that you can answer is not limited to the above list. To gain the most from this course you should try to apply the principles of Model to your everyday life and practice to planning and decisions on issues applicable to Educational Administrators in your institutions, establishments and organizations.

We hope you enjoy your acquaintance with the National Open University of Nigeria (NOUN). We wish you every success in the future.

PROACH TO EDUCATIONAL PLANNING

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…CHES IN MODEL BUILDING

UNIT 1 STRUCTURALIST APPROACHES IN MODEL BUILDING

CONTENTS

1.0 INTRODUCTION

A structural model specifies how well some variables could predict some other variables. It helps in the measurement of the model itself such that decisions are taken in the right manner. The units emphasis however on structural equation modelling and the steps involved in the analysis.

2.0 OBJECTIVES

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

i. describe structural model approach

ii. explain measurement modelling

iii. explain the structural equation modelling

iv. state the steps in performing SEM Analysis

3.0 MAIN CONTENT

3.1 Structural model: A structural model specifies how well some variables could predict some other variables. Because prediction involves relationships, it could be viewed as a regression model. Also, since the relationships form a "chain" or a "path," it is also known as path model. When two models are combined, they form a structural equation model. The following is an example given by Lomax (1992). Assume that based upon literature research, a researcher hypothesizes that "home background" could be a predictor to "school achievement," and "school predict "career success", he should define such vague concepts as home background, school achievement, and career success. The next logical step he should go is to develop instrument and data collection schemes to measure those latent constructs.

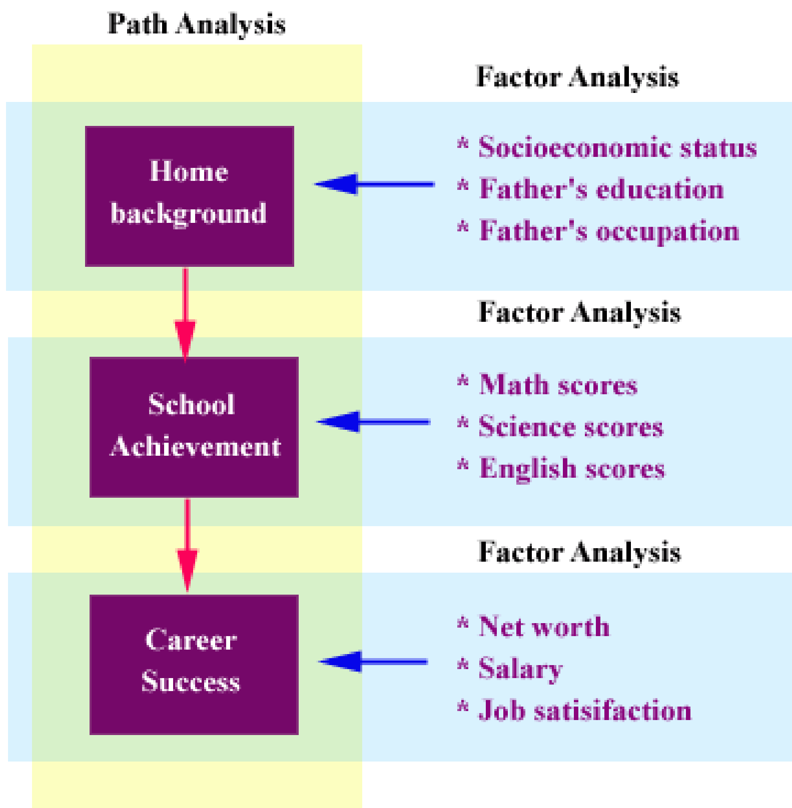

Fig 1: showing LOMAX Structural Equation Model

This example is simplified. A real-life structural equation model is more complicated than that. While applying an input-output model to research on Web-based instruction, researchers may find only one dependent variable and independent variable, namely, test performance and the treatment. However, while applying the input-process-output structural framework, between the ved many other observed and latent variables. To perfect the structuralist view of approach to modeling in educational planning, the following models are equally important for consideration.

3.2 Measurement model: A measurement model, as its name implies, is about measurement and data collection. In the section concerning reliability and Cronbach Alpha, we discussed how researchers develop instrument with high reliability and low measurement error. In factor analysis, researchers extract latent variables from observed variables. The relationships are indicated in the following figure. The ellipse represents a latent variable such as a mental construct; the rectangles represent observed variables, which are items in a scale. The circles denote measurement errors.

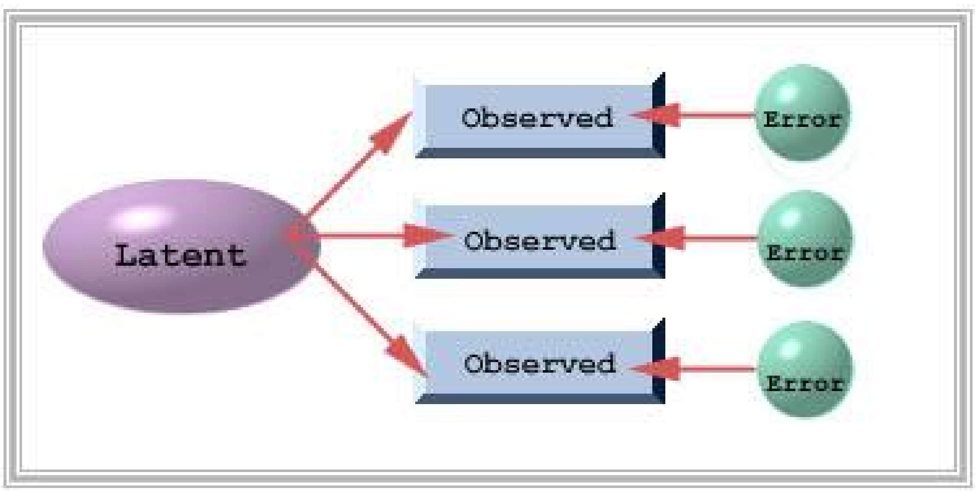

Fig 2: Showing Measurement Model

equation modeling (SEM) is a statistical technique for testing and estimating causal relationships using a combination of statistical data and qualitative causal assumptions. This view of SEM was articulated by the geneticist Sewall Wright (1921), the economists Trygve Haavelmo (1943) and Herbert Simon (1953), and formally defined by Judea Pearl (2000) using a calculus of counterfactuals.

Structural Equation Models (SEM) allows both confirmatory and exploratory modeling; thus, it is suited to both theory testing and theory development. Modeling usually starts with a hypothesis, represents it as a model, operationalises the constructs of interest with a measurement instrument, and tests the fit of the model to the obtained measurement data. The causal assumptions embedded in the model often have falsifiable implications which can be tested against the data.

With an initial theory SEM can be used inductively by specifying a corresponding model and using data to estimate the values of free parameters. Often the initial hypothesis requires adjustment in light of model evidence. When SEM is used purely for exploration, this is usually in the context of exploratory factor analysis as in psychometric design.

Among the strengths of SEM is the ability to construct latent variables: variables which are not measured directly, but are estimated in the model from several measured variables each of which is predicted to 'tap into' the latent variables. This allows the modeler to explicitly capture the unreliability of l, which in theory allows the structural relations between latent variables to be accurately estimated. Factor analysis, path analysis and regression all represent special cases of SEM.

In SEM, the qualitative causal assumptions are represented by the missing variables in each equation, as well as vanishing covariances among some error terms. These assumptions are testable in experimental studies and must be confirmed judgmentally in observational studies.

3.4 Steps in performing SEM analysis

Model specification

Since SEM is a confirmatory technique, the model must be specified correctly based on the type of analysis that the modeller is attempting to confirm. When building the correct model, the modeller uses two different kinds of variables, namely exogenous and endogenous variables. The distinction between these two types of variables is whether the variable regresses on another variable or not. As in regression the dependent variable (DV) regresses on the independent variable (IV), meaning that the DV is being predicted by the IV. In SEM terminology, other variables regress on exogenous variables. Exogenous variables can be recognized in a graphical version of the model, as the variables sending out arrowheads, denoting which variable it is predicting. A variable that regresses on a variable is always an endogenous variable, even if this same variable is also used as a variable to be regressed on. Endogenous variables are recognized as the receivers of an arrowhead in the model.

SEM is more general than regression. In particular a variable can act as both independent and dependent variable. This makes SEM more powerful than linear regression.

Two main components of models are distinguished in SEM : the *structural model* showing potential causal dependencies between endogenous and exogenous variables, and the *measurement model* showing the relations between latent variables and their indicators. Exploratory and Confirmatory factor analysis models, for example, contain only the measurement part, while path diagrams can be viewed as an SEM that only has the structural part.

In specifying pathways in a model, the modeller can posit two types of relationships: (1) *free* pathways, in which hypothesised causal (in fact counterfactual) relationships between variables are tested, and therefore are left 'free' to vary, and (2) relationships between variables that already have an estimated relationship, usually based on previous studies, which are 'fixed' in the model.

A modeller will often specify a set of theoretically plausible models in order to assess whether the model proposed is the best of the set of possible models. Not only must the modeller account for the theoretical reasons for building the model as it is, but the modeller must also take into account the number of data points and the number of parameters that the model must estimate to identify the model. An identified model is a model where a specific parameter value uniquely identifies the model, and no other equivalent formulation can be given ue. A data point is a variable with observed scores, like a variable containing the scores on a question or the number of times respondents buy a car. The parameter is the value of interest, which might be a regression coefficient between the exogenous and the endogenous variable or the factor loading (regression coefficient between an indicator and its factor). If there are fewer data points than the number of estimated parameters, the resulting model is "unidentified", since there are too few reference points to account for all the variance in the model. The solution is to constrain one of the paths to zero, which means that it is no longer part of the model.

3.5 Estimation of free p arameters

Parameter estimation is done comparing the actual covariance matrices representing the relationships between variables and the estimated covariance matrices of the best fitting model. This is obtained through numerical maximization of a *fit criterion* as provided by maximum likelihood estimation, weighted least squares or asymptotically distribution-free methods. This is often accomplished by using a specialized SEM analysis program of which several exist.

3.6 Assessment of fit

Assessment of fit is a basic task in SEM modeling: forming the basis for accepting or rejecting models, and more usually, accepting one competing model over another. The output of SEM programs includes matrices of the ween variables in the model and assessment of fit essentially calculating how similar the predicted data are to matrices containing the relationships in the actual data.

Formal statistical tests and fit indices have been developed for these purposes. Individual parameters of the model can also be examined within the estimated model in order to see how well the proposed model fits the driving theory. Most, though not all, estimation methods make such tests of the model possible.

Of course as in all statistical hypothesis tests, SEM model tests are based on the assumption that the correct and complete relevant data have been modeled. In the SEM literature, discussion of fit has led to a variety of different recommendations on the precise application of the various fit indices and hypothesis tests. Measures of fit differ in several ways. Traditional approaches to modeling start from a null hypothesis, rewarding more parsimonious models (i.e., those with fewer free parameters), others such as AIC judge focus on how little fitted values deviate from a saturated model (recovering the measured values), taking into account the number of free parameters used. Because different measures of fit capture different elements of the fit of the model, it is appropriate to report a selection of different fit measures.

Some of the more commonly used measures of fit include:

- **Chi-Square:** A fundamental measure of fit used in the calculation of many other fit measures. Conceptually it is a function of the sample size ween the observed covariance matrix and the model covariance matrix.

- Root Mean Square Error of Approximation (RMSEA)
- Standardized Root Mean Residual (SRMR)
- Comparative Fit Index (CFI)

For each measure of fit, a decision as to what represents good-enough fit between model and data must reflect other contextual factors such as sample size (very large samples make the Chi-square test overly sensitive, for instance), the ratio of indicators to factors, and the overall complexity of the model.

3.7 Model Modification

The model may need to be modified in order to improve the fit, thereby estimating the most likely relationships between variables. Many programs provide modification indices which report the improvement in fit those results from adding an additional path to the model. Modifications that improve model fit are then flagged as potential changes that can be made to the model. In addition to improvements in model fit, it is important that the modifications also make theoretical sense.

3.8 Interpretation and Communication

The model is then interpreted and claims about the constructs are made based on the best fitting model. Caution should always be taken when making claims of causality even when experimentation or time-ordered studies have been *odel* must be understood to mean: "a model that conveys causal assumptions," not necessarily a model that produces validated causal conclusions. Collecting data at multiple time points and using an experimental or quasi-experimental design can help rule out certain rival hypotheses but even a randomized experiment cannot rule out all such threats to causal inference. Good fit by a model consistent with one causal hypothesis does not rule out equally good fit by another model consistent with a different causal hypothesis. However careful research design can help distinguish such rival hypotheses.

4.0 CONCLUSION

Empirically, structural models do not appear to be able to match observed yield spreads on corporate bonds. This may have less to do with shortcomings of models than with our view of yield spreads as arising primarily from credit risk. Thus, a better understanding of the composition and drivers of yield spreads may help gauge the value of structural models better.

5.0 SUMMARY

1. Structural models offer an intellectually appealing approach to modeling credit risk.
2. Measurement modelling: It is the measurement and data collection for proper decision making.

Modeling: is a statistical technique for testing and estimating causal relationships using a combination of statistical data and qualitative causal assumptions.

4. Steps in performing SEM Analysis: model specification, estimate of free parameter, assessment of fit eg chi-square, Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Residual (SRMR), Comparative Fit Index (CFI)

6.0 TUTOR-MARK ASSIGNMENT

1. Draw the Structural Model of model school and the measurement Models most applicable to it.
2. Structural Equation Modeling is a statistical technique for testing and estimating causal relationships…. Discuss?
3. Discuss the necessary steps involved in Structural Model in Educational Planning.

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IST APPROACHES IN MODEL BUILDING

1.0 INTRODUCTION

Behaviour is a dynamic concept which is attributed to every organization, institute and sectors including the educational sector especially in the planning process and execution of the plans. Based on these, this unit examines the approach in line with Attitude Change, Behaviour Change, Change Strategies, instructional Innovation, Teacher Attitudes, Teacher Behaviour and Teaching Methods in model building.

2.0 OBJECTIVES

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

i. explain model building in relation to Behaviouralist view.

ii. relate the following concepts to Behaviouralist approach to model building to educational planning: attitude Change, Behaviour Change, change Strategies, instructional Innovation, teacher Attitudes, teacher Behaviour, teaching Methods.

3.0 MAIN CONTENT

3.1 Stage Theories of Behaviour Change

Behaviour change occurs in stages or steps, movement through these stages is unitary or linear; rather, cyclical, involving a pattern of adoption, maintenance, relapse, and re-adoption over time.

The first of these stages is termed pre-contemplation. In this stage, there is no intent on the part of the individual to change his or her behaviour in the foreseeable future.

The second stage is called contemplation, where people are aware that a problem exists and are seriously considering taking some action to address the s stage, they have not made a commitment to undertake action.

The third stage is described as preparation, and involves both intention to change and some behaviour, usually minor, and often meeting with limited success.

Action is the fourth stage where individuals actually modify their behaviour, experiences, or environment in order to overcome their problems or to meet their goals.

The fifth and final stage, maintenance, is where people work to prevent relapse and consolidate the gains attained in the action stage. The stabilization of behaviour change and the avoidance of relapse are characteristic of the maintenance stage.

Even with successful behaviour change, people will likely move back and forth between the five stages for some time, experiencing one or more periods of relapse to earlier stages, before moving once again through the stages of contemplation, preparation, action and eventually, maintenance. In successful behavioural change, while relapses to earlier stages inevitably occur, individuals never remain within the earlier stage to:

MAINTENANCE: practice required for the new behaviour to be consistently maintained, incorporated into the repertoire of behaviours available to a person at any one time.

ACTION: people make changes, acting on previous decisions, experience, information, new skills, and motivations for making the change.

pares to undertake the desired change - requires gathering information, finding out how to achieve the change, ascertaining skills necessary, deciding when change should take place - may include talking with others to see how they feel about the likely change, considering impact change will have and who will be affected.

CONTEMPLATION: something happens to prompt the person to start thinking about change - perhaps hearing that someone has made changes - or something else has changed - resulting in the need for further change.

PRECONTEMPLATION: changing behaviour has not been considered; person might not realise that change is possible or that it might be of interest to them.

Prochaska's and DiClemente's model has received considerable support in the research literature. Their model has also been shown to have relevance for understanding, among other things, patterns of physical activity participation and adherence and would have relevance in bringing about change in travel behaviours. Consistent with the above perspective, Sallis and Nader (1988) also have suggested a stage approach to explaining movement behaviour, particularly in family groups, with research aimed at understanding better the cyclical patterns of movement activity

SOCIAL FEATURES

- nature of personal relationships; expectations of class, position, age, gender; access to knowledge, information.

- the behaviours and attitudes considered acceptable in given contexts - eg. relating to sex, gender, drugs, leisure, participation.

ETHICAL & SPIRITUAL

- influence of personal and shared values and discussion about moral systems from which those are derived – can include rituals, religion and rights of passage.

LEGAL FEATURES

- laws determining what people can do and activities to encourage observance of those laws .

POLITICAL FEATURES

- systems of governance in which change will have to take place - can, for example, limit access to information and involvement in social action.

RESOURCE FEATURES

- affect what is required to make things happen - covers human, financial and material resources; community knowledge and skills; and items for exchange involvement, including adoption, maintenance, and relapse, and interventions aimed at minimizing the amount of time individuals spend in the relapse stage as well as maximizing time spent in action or maintenance.

This stage approach is contrasted to the "all or none" approach to physical activity participation that often characterized early research on exercise adherence. Such a staged approach sits well with any school based program that is focused on travel behaviour change – given that the context in which the vould see fluctuations in the positive and negative influences according to such things as work and time demands of family members, weather, events or incidents in the local neighbourhood that may influence perceptions of safety.

Parallel with the work of Prochaska and DiClemente, Rogers, (1983) also developed a stage-based theory to explain how new ideas or innovations are disseminated and adopted at the community and population levels. Rogers identified five distinct stages in the process of diffusion of any new initiative or innovation. These are knowledge, persuasion, decision, implementation, and confirmation. Rogers argued that the diffusion of an innovation is enhanced when the perceived superiority of an innovation is high compared to existing practice (i.e. the relative advantage), and when the compatibility of the innovation with the existing social system is perceived to be high (i.e. compatibility).

Other important influences on the diffusion process are said to be complexity, *triability*, and *observability*, with innovations which are of low complexity, easily observed, and that are able to be adopted on a trial basis, being associated with greater adoption and swifter diffusion. Building success and comfort during the early stages of the implementation of Schools.

Rogers classifies individuals as innovators, early adopters, early majority, late majority, late adopters, and laggards, dependent upon when during the overall diffusion process they adopt a new idea or behaviour. While this model has not been tested empirically to date, it has been adapted and applied in health in conjunction with social learning theory and/or self-efficacy theory, with some success.

3.2 Other Theories to Consider: Personality Theories

Personality theories explain behaviour largely in terms of stable traits or patterns of behaviour which are viewed as resistant to change and inalterable. The classification of individuals into the five categories of innovators, early adopters, early majority, late majority, late adopters, and laggards is an example of this kind of approach to understanding behaviour.

A major limitation of personality theories is that they do not take account of important aspects of the physical, social and economic environments, or the previous experiences of the individual, which also are known to strongly influence behaviour. For this reason, personality theories alone now are generally considered inadequate to explain behaviour change.

Learning and Behaviour Theories

Learning theorists have demonstrated that behaviour can be changed by providing appropriate rewards, incentives, and/or disincentives. In learning or behaviourist approaches, these rewards and incentives are typically incorporated into structured reinforcement schedules, and the process of behaviour changes is often termed behaviour modification.

While effective in bringing about behaviour change, such approaches require a high level of external control over both the physical and social environment, and the incentives (or disincentives) used to reinforce certain behaviours and discourage others. This kind of control is hard to maintain in real life settings, urist approaches are subject to a number of limitations.

Social Learning Theory

Social learning theory is similar to learning and behaviour theories in that it focuses on specific, measurable aspects of behaviour. Learning theories, however, view behaviour as being shaped primarily by events within the environment, whereas social learning theory views the individual as an active participant in his or her behaviour, interpreting events and selecting courses of action based on past experience.

Again, one important theory deriving from social learning theory which has had a major impact on many current models of behaviour change is that of self-efficacy. As stated earlier, self-efficacy expectations have to do with a person's beliefs in his or her abilities to successfully execute the actions necessary to meet specific situational demands. Such expectations have been found to be consistently related to behaviour across a wide range of situations and populations sub-groups.

Socio-Psychological Theories

Social psychological theories are concerned with understanding how events and experiences external to a person (i.e. aspects of the social situation and physical environment) influence his or her behaviour.

Emphasis is placed on aspects of the social context, in which behaviour occurs, including social norms and expectations, cultural mores, social stereotypes, group dynamics, cohesion, attitudes and beliefs. A number of useful concepts sychological theories, including attribution, locus of control, and cognitive dissonance, to name a few.

Social Cognitive App roaches

Social cognitive approaches combine aspects of social psychological theories with components of both social learning theory and cognitive behavioural approaches. Social-cognitive approaches emphasize the person's subjective perceptions and interpretations of a given situation or set of events, and argue that these need to be taken into account if we are to understand adequately both behaviour and the processes of behaviour change.

A number of social psychological concepts have been found to be consistently related to behaviour change across a wide range of situations. For example, the social reality of a group (e.g. peer group, school group, family group etc.) will affect an individual's behaviour. All groups are characterized by certain group norms, beliefs and ways of behaving, and these can strongly affect the behaviour of the group members.

Expectations of significant or respected others can also have a strong influence on a person's behaviour. This phenomenon has been most consistently demonstrated in the early research on self-fulfilling prophecies, which showed that teachers' expectations of their students were consistently related to the students' subsequent performance, even when these expectations were based on falsified information. Thus, support and encouragement, or conversely, low expectations from significant or respected others, can affect and bring about, (or not), changes in individual behaviour.

The Health Belief Model attempts to explain health- behaviour in terms of individual decision-making, and proposes that the likelihood of a person adopting a given health-related behaviour is a function of that individual's perception of a threat to their personal health, and their belief that the recommended behaviour will reduce this threat.

Thus, a person would be more likely to adopt a given behaviour (e.g. walk or cycle regularly) if non-adoption of that behaviour (e.g. unclean air or confused traffic situations) is perceived as a health threat and adoption is seen as reducing that threat.

To date, the Health Belief Model has not received consistent or strong support in explaining behaviour change. When the concept of self-efficacy is added to the model, however, prediction of behaviour increases.

Social Marketing

Another approach that has been used to bring about behaviour change is that of social marketing. The concept of social marketing is based on marketing principles and focuses on four key elements, including:

- development of a product
- the promotion of the product
- the place
- the price.

As such, this approach is not so much a theory of behaviour change but a proposed framework, which situates people as "consumer" who will potentially argument, given the appropriate selling techniques are applied. It is then assumed that the "buying in" to that idea by individuals will result in behaviour change.

Theory of Interpersonal behaviour

Habit strength is another concept that has been found to be important in predicting or changing behaviour. Habit is an important element of the theory of interpersonal behaviour, which proposes that the likelihood of engaging in a given behaviour is a function of:

a. the habit of performing the behaviour

b. the intention to perform the behaviour

c. conditions which act to facilitate or inhibit performance of the behaviour.

In turn, intentions are said to be shaped by a cognitive component, an affective component, a social component, and a personal normative belief. The theory of interpersonal behaviour argues that as behaviours are repeated, they become increasingly automated, and occur with little conscious control. That is, while individuals must first intend to participate in a given behaviour or activity, as the behaviour or activity is repeated over many occasions, participation becomes habitual and requires little conscious intervention. Driving a car along a familiar street is cited as an example.

To date, this model has not been tested as extensively as have the theory of reasoned action or the theory of planned behaviour.

tional model building rest on the following: social features, cultural features, ethical & spiritual, legal features, political features and resource features.

5.0 SUMMARY

In summarizing the various stage models of behaviour change in behavioural modeling are viewed as a cyclical process that involves five stages of:

a. awareness of the problem and a need to change

b. motivation to make a change

c. skill development to prepare for the change

d. initial adoption of the new activity or behaviour, and

e. maintenance of the new activity and integration into the lifestyle.

Five stages of behaviour change. Examples of content and processes :

a. Awareness of the problem and a need to change provision of, or ways to seek information on the dependence on motorised travel; evidence of the greenhouse effect; issues relating to building relationships and fitness.

b. Motivation to make a change. Benefits of increased personal fitness; benefits of leaving the car at home – eg. Environmental and social.

c. Skill development to prepare for the change Mapping of the local area to identify alternative forms of travel, ways to negotiate with reluctant family members or peers to manage the need to carry; strategies for trip chaining and travel blending

d. Initial adoption of the new activity or behaviour. Such as self monitoring of newly adopted behaviours to, opportunities for reflections and comparisons activity and integration into the lifestyle Provision of feedback on how the change is going, and an injection of new ideas or strategy.

6.0 TUTOR-MARK ASSIGNMENT

1. Discuss the model building in relation to behaviouralist view.

2. Relate the following concepts to behaviouralist approach to model building: attitude Change, behaviour Change, change Strategies, instructional innovation, teacher Attitudes, teacher Behaviour and teaching Methods

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A CONCEPT

1.0 INTRODUCTION

Planning is an important action which must be taken by all sectors in order to achieve its stated goals. This chapter examines the meaning of planning, planning need and its importance, characteristics of a good plan, advantages of a good planning and limitation of planning.

2.0 OBJECTIVES

At the of the chapter, students should be able to:

i. define planning
ii. state planning need and its importance
iii. State characteristics of a good plan
iv. list advantages of a good planning
iv. State limitation of planning

3.0 MAIN CONTENT

3.1 DEFINITION OF PLANNING

- Planning involves selecting missions and objectives and the actions to achieve them. It requires decision making i.e. choosing from among alternative future course of actions.
- Planning bridges the gap from where we are to where we want to go, it make it possible for things to occurred which would not otherwise happen.
- Planning refers to determining future course of action to achieve the objectives with optimum utilization of available resources.

3.2 PLANNING – NEED AND IMPORT ANCE

Planning is the primary management function which drives the other functions such as organizing, leading and controlling activities. In the absence

...e managers to organize people and resources. The ...g is useless without the plan. Thus for effectively managing the business, there should be a plan which gives direction as to what should be done to achieve the objectives.

The importance of planning is expressed as follows:

(1) Minimises Risk and Uncertainty

In today's highly complex nature of business, organization can not afford to take decisions intuitively. By providing a more rational, fact based procedure for making decision, planning allows managers and organizations to minimize risk and uncertainty.

(2) It Leads to Success

Planning is a proactive process. It helps to shape the environment to the benefit of the company. This helps to perform better and achieve success.

(3) To Face Increasing Comp etition

Today, a business concern has to face competition not only in the domestic market but also in International markets. To face such fierce competition, proper planning in all functional areas is a must.

(4) It Facilitates Control

In planning a manager sets goals and devises the action plan to achieve these goals. Plan thus becomes the standard or benchmarks against which the performance is compared and control is exercised in case of any difference between the planned and actual performance.

(5) To Provide for Comp lex Technological Changes

Technology is changing rapidly and the existing machines and processes are becoming obsolete at faster rate. With proper planning, it is possible to keep pace with technological changes to the advantage of the organization.

(7) It Focuses on Goals

Planning determines the activities which are goal directed.

TERISTICS OF A GOOD PLAN

l plan are:

(1) It is based on a clearly defined, unambiguous objectives

(2) It should be simple

(3) Should be able to define clear actions and standards

(4) Should be flexible to accommodate changes

(5) Should make best utilization of available resources.

(6) Should lead the organization towards success.

3.4 ADVANTAGES OF PLANNING

The advantages of planning can be summarized as follows:

(1) Planning helps the manager to visualize future challenges and opportunities and helps the organization to be proactive to face future uncertainties.

(2) It helps to make all activities purposeful by eliminating or avoiding those activities which do not contribute to achievement of objectives.

(3) It helps the manager to analyze all the variables affecting the performance

(4) It encourage achievement of actions

(5) It provides a basis for diagnosing and control

(6) It helps to visualize the firm in its entirety

(7) It helps to achieve the maximum utilizations of available resources at the discretion of the manager.

3.5 LIMITATIONS OF PLAN NING

(1) Planning is dependent on correctness of information. Any inaccuracy in the information provided may lead to failure of the plans and affect them adversely.

(2) Uncertainty. An element of uncertainty always exists in the plan as the forecasts cannot be 100% accurate and reliable.

(3) Rigidity, Planning limits the flexibility of course actions.

(4) Planning consumes lot of resources both time and money

(5) Planning is often complained of curbing the human creativity.

Planning is viewed as an inevitable course of action for any establishment to succeed. This is center round its needs and importance, characteristics, merits and its limitation. Planning refers to determining future course of action to achieve the objectives with optimum utilization of available resources. The need and importance are: Minimises Risk and Uncertainty, It Leads to Success, to Face Increasing Competition, it Facilitates Control, to Provide for Complex Technological Changes and it Focuses on Goals.
Clearly defined, unambiguous objectives, it should be simple, should be able to define clear actions and standards, should be flexible to accommodate changes, should make best utilization of available resources, and should lead the organization towards success were all its characteristics.

5.0 SUMMARY

In this unit you have learnt what planning is, its importance, characteristics of a good plan, its advantages and limitations.
In the next unit, you will be introduced to Educational planning as a concept.

6.0 TUTOR-MARK ASSIGNMENT

1. Define planning? Why is it essential to plan?
2. Discuss the importance of planning
3. Discuss the characteristics of a good plan.

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PLANNING AS A CONCEPT

1.0 INTRODUCTION

Planning is applicable to all the sectors in an economy, education inclusive, this unit seeks to examine planning from the educational sector with a view to consider the planning process, methods, the educational system analysis and the necessary steps in educational planning.

2.0 OBJECTIVES

At the end of this chapter, students should be able to:

i. define Educational planning
ii. state the educational planning process
iii. state the educational planning methods
iv. discuss the educational planning process
v. state the steps in educational planning

3.0 MAIN CONTENT

3.1 Meaning of educat ional planning

Educational planning is the roadmap. It focuses the attention of administration, board of education, teachers, students and community members, and helps determine where the school district should be going and how to get there. It helps identify where the pitfalls are over the short-term. Without planning, the operational and functional performance of the school district will be less than optimal and the overall objectives and goals of the district will be difficult, to achieve. Educational planning is an organized thought process participated in by administration, board of education, teachers, students and community members. The ultimate result is the determination of long-term goals and objectives, and the short-term implementation of specific goals using focused techniques, tactics, and strategies which will permit the school district to meet long term goals and objectives. Planning in general form is a process of establishing priorities for future actions in an attempt to solve economic problems in different sectors, nce of limited resources. It implies given thoughts to riorities of a nation.

Educational planning involves the taking of decisions for future actions with the view to achieving predetermined objectives through optimum use of scarce resources. The scope of planning education covers curriculum planning, target setting manpower within the education sector. Thus educational planning comprises the following functions:

- **Predetermination of Objectives:** These involve setting targets or goals clearly in relation to national development goals.
- **Utilization of Scarce Resources:** This takes into consideration the optimum allocation of the scarce resources in education such as "time" in respect to students' time, teachers' time in relation to the level of knowledge to be required.
- **Decision Making:** This refers to the actual preparation of the plan for each level at which decisions are taken.

3.2 Educational planning process

Educational planning usually takes place at the national level, State level, local and institutional levels. At the national and State levels, the plans lay down broad objectives, strategies, and targets while the details are worked out at the local and institutional levels.

Planning at the national or state levels is referred to as "Macro planning" and planning at the local or institutional levels is known as "Micro planning"

Macro planning, in addition to the point made above, is sometimes called global view of educational development. It presents a national view of the fundamental aspects of educational development such as educational financing, educational reform and teacher training.

Micro planning is described as planning at the grass roots. This is so because it is concerned with an indepth study of educational problems as they are perceived at the local and institutional levels. It is at this level that king into account both the general orientations of ch includes educational initiatives and reforms e.g **Operation Reach All Secondary Schools** (ORASS), 6-3-3-4 system etc which reflects a desire to improve the functioning of the education system by reinforcing planning activities at the grassroots. The various areas involved in micro planning can be classified into three, namely

(1) School mapping

(2) Educational disparity

(3) Internal efficiency.

School Mapping: This is concerned with the problems linked with access and accessibility to the education system. It seeks to satisfy effectiveness, and to minimize costs as much as possible while taking into account the overall objects.

Educational Disparity: This refers to a situation within the education system whereby regions, state or local governments do not enjoy the same level or opportunities for educational development.

Internal efficiency: Educational planning is not only concerned with the problems of allocation of resources but also with the problems of efficiency. Utilization of resources indicators such as the enrolment ratio, the dropout rate, the flow rate, the student teacher ratio, the unit cost etc show the level of efficiency of the education system.

The main phases in the planning process are:

(i) Policy making

(ii) Plan formulation

(iii) Plan implementation and evaluation.

Policy making is often performed by the "Government of the day". At this stage, direction is given to the policy maker as to whether or not it is possible to undertake a particular educational project. This phase is also referred to as plan technology.

is an administrative function. This involves the use ne setting up of an organization for the several types of education projects, and allocation of resource needed for every project.

- Plan evaluation may continue throughout the planning ache and it may be performed as the final attestation of a finished projects. The different phases in the planning process are not independent of each other but are all inter linked.

3.3 Educational p lanning Methods

Education in the first place is a good that provides benefits not only to the recipient but also to the community; it is not possible to use the market mechanism for the provision of education. This is due to the fact that potential "Customers" are not likely to willingly express their demand.

Planning the development of an educational system can be carried out by the use of these methods. These are;

1. **The Social Demand Approach:** There is no single definition for the term social demand. It has become acceptable to use it when a government decides that education should be provided to all those who wish to attend schools and who are likely to benefit and have the ability to do so. For instance in the planning of the Dutch educational system, it is implicitly stated that "if a sufficiently qualified citizen stands at the door of any type of schools he must be admitted, and it is the responsibility of the appropriate government authorities to anticipate his requests so that schools capacity will be adequate to accommodate him. From the discussion above, it is clear that if the government in power believed that the citizens of that state or country have to be given the opportunity to satisfy their desire for education, all must be done to provide that education for them. This was the situation in the former western and eastern regions of Nigeria when the Universal Primary Education (UPE) and Junior Secondary Schools (JSS) were introduced in 50's and 1982 respectively

nd approach usually involves large expansion of the itial stage. This covers the areas of enrolment and expansion of classroom facilities.

- **The Manpower Forecasting Approach:** Planning educational development may also be based on the manpower need of a country. In a newly independent country, there is bound to be a shortage of skilled manpower to fill the posts that the departing expatriates were occupying.

In order to forecast the future manpower requirement, a country may adopt one or more of the following methods of estimating manpower needs.

(i) **The Employer's Opinion Method:** This involves asking employers, through the use of questionnaires, how much and what kind of educated manpower they expect to employ in the next few years. In some countries the employers to be covered may be restricted. For instance, in Nigeria, this is stated as establishments employing not less than 10 persons. When the questionnaires are filled and returned by the various employers, the estimates provided will also be added up. After the addition, the number estimated as retiring, dying or migrating during the period will be subtracted to provide a forecast of the increase in effective demand for educated labour by the target year.

(ii) **The Incremental Labour Out Ratio Method:** In this method, labour is used to mean a particular type of manpower such as medical practitioner and output means industrial output or the national incomes. For this method to be applied, one requires time series data on output per man cross classified by sectors, occupation and educational qualification.

(iii) **The Density Ratio Methods:** This is sometimes referred to as the "ratio of saturation" method which is the favourite of the Russian planers. It involves the following two stages: firstly, stable fractions of qualified manpower in an economic sector are estimated. Secondly, this fraction is applied to the population forecast of the total labour force as distributed amongst the various sectors of one economy.

omparison Method: This method is applicable to ping countries that lack adequate manpower data. It could be applied on its own but it is more often applied in conjunction with other methods

- **The Rate of Return Approach:** This approach takes education as an investment good. Under the social demand approach, education is seen as a service that should be provided to the people so that their future outlook to life and behaviour in society would be better. The rate of return approach is taken to mean the provision of skills and knowledge to the citizens so that the national output of the society may be increased. This educational investment has to be weighed against or compared with other investments in the nation such as roads communications, health industry and so on.

3.4 Educational System Analysis: The education sector is a system which comprises of flows of different resources into, within and outside the school system. These resources flow from year to year. Students' trend in the educational system could be yearly movement from different school classes, different grade or level. This and many more called for a proper diagnosis of the sector. The proper way to get this done is to analyse, which gave birth to the concept of educational system analysis.

According Jolly (1960), a mathematical model of the flows within the school system is a modified analysis based on students enrolment model, Repetition model, Teachers model, teaching learning model etc. For instance, to determine the students flow rate, certain parameters, must be considered. These include: Enrolment Ratio which also consist of Age- Specific Ratio, Level Enrolment Rate, Crude Ratio (which is also known as General or Overall Ratio). The level enrolment ratio can be divided into (a) Gross Level Enrolment Ratio (GLER) and Net level Enrolment Ratio (NLER). Pupil-Teacher Ratio and Sex Ratio can also not be over emphasised in the discourse of the **ANALYTICAL APPROACH TO EDUCATIONAL PLANNING**

lanning

Analysis

There are many variables which affect planning both internal to the organization as well as external. Most of the opportunities will be spotted in the external environment. So, it is essential to seen both external as well as internal environments for future opportunities.

SWOT (Strength Weakness Opportunity Threat) analysis is helpful in identifying our strengths and looking for opportunities which fail in our strength area. The analysis of external environment helps to anticipate likely threats so that organizations can take steps to minimize the adverse effect. The setting up of realistic objectives depends upon the awareness regarding the opportunities and environment in which the company is operating. Opportunities are analyzed in the light of markets, customer, competition etc.

Step 2: Establishing Objectives

The second step in planning deals with setting the objectives for the organization. The Objectives should be clear and unambiguous so that there is no difficulty in understanding them by all concerned.

Step 3: Considering Planning Premises

Planning premises refer to the assumptions about the environment in which the plan is to be carried out. Each planning should agree to the premises. The critical planning premises include forecasts, applicable basic policies and existing company plans.

Forecasting is crucial and important in premising. Because of the complexity and uncertainty of the future, it is not realistic and profitable to make assumptions regarding every minute detail. So, premises should be limited to assumptions that are critical or strategic to a plan.

Step 4: Identifying Strategic Alternatives

This step involves the search and development of alternative course of actions to achieve the objectives. Many alternatives are developed at this stage to accomplish objectives.

rnatives

ives is a crucial step as the strong and weak points of each alternative is to be evaluated, Depending upon the objectives, the criteria for evaluation can be developed and weight age is to be given to each criteria. This presents an objective evaluation of alternatives giving no chance for any subjectivity. Quantitative techniques can be utilized for evaluating the alternative course of action.

Step 6: Selection of the Best Alternati ve

This is a major decision and the particular plan is adopted at this stage. The operational research techniques here help to select a specific course of action which is the best under given conditions.

Step 7: Preparation of Supp ort Plan and Budget

Once the decision is made regarding the selection of the course of action, then the support plans are to be developed to support the basic plan. Then to give meaning to the plans, budgets are prepared to implement the plans.

The overall budget is to be established which is then to be established for each department. Budgets act as standard against which the actual performance is to be compared.

Step 8: Implementation

This marks the beginning of the execution stage and end of planning. The progress is to be monitored and control actions are to be initiated in case of deviation from the plans. The effective feedback system helps to modify the plans.

4.0 CONCLUSION

This chapter has been able to define educational planning as the planning which takes place in the educational sector, its process: School mapping, Educational disparity and internal efficiency. This includes: Policy making, Plan formulation, Plan implementation and evaluation, the educational methods, the Social Demand Approach, manpower approach, employer's Opinion Method, The Density Ratio Methods, international comparison methods etc

*Educational planning is an organized thought process participated in by administration, board of education, teachers, students and community members.

* Educational Planning process which takes place at the national or state levels is referred to as "Macro planning" and planning at the local or institutional levels is known as "Micro planning "

* Educational planning methods include the Social Demand Approach, manpower approach; employer's Opinion Method, The incremental Labour Out Ratio Method, the Density Ratio Methods, international comparison method, and rate of return.

* There are eight steps to follow in Educational planning.

6.0 TUTOR-MARK ASSIGNMENT

1. Define Educational Planning?
2. Discuss in detail the Educational planning process.
3. Discuss in detail the Educational planning methods.
4. Highlight the various steps in educational planning in chronological manner.

7.0 REFERENCES / FURTHER READINGS

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UNIT 5 IMPORTANT ELEMENT S IN PLANNING

CONTENTS

1.0 INTRODUCTION

There are important elements which have to be considered in planning. Educational systems are general, but they vary in some elements. This unit examines these elements which include: mission, objective, strategies tactics, policies, procedure, methods, rules, programmes, standard, schedules and budget.

2.0 OBJECTIVES

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

i. discuss the all elements in planning.

3.0 MAIN CONTENT

3.1 SOME IMPORTANT ELEMENTS IN PLANNING

3.1.1 Mission

Mission states the purpose for the existence of the institution. It states what type of learners it serves, what needs it satisfies and what type of education it offers.

In general, the mission statement indicates the boundaries for an institution's activities. The mission statement should be neither too broad and vague nor too narrow and specific. For example, a mission statement "To serve Nigerian" is too vague, on the other hand, mission statement "To make tennis balls' is too specific and narrow. None of the above mission statement outlines meaningful benefits to their purpose or provides guidance to educational manager. A typical example of a well state mission is "***************"

3.1.2 Objectives

Objectives are goals which the management wishes the institution to achieve. It is a desired outcome. These are the end points towards which all business activities like organizing, staffing, directing and controlling are practice of management points out eight key areas ...rmance and results have to be set. These are market standing, innovations, productivity, physical and financial resources, profitability, manager performance and development, worker performance and attitude and public responsibility. Therefore in education, the following are important:

Characteristics of Objectives

- Clear and specific
- Stated in writing
- Ambitious but realistic
- Consistent with one another in case of multiple objectives
- Quantifiable and measurable
- Tied to a particular time period

The following example illustrates the correct and incorrect statement of the objectives. Basically the benefits derived from objectives are:

- They provide a basis for planning
- They motivate the individuals and departments to do purposeful actions
- They act as a basis for control function
- They facilitate communication and limits the misunderstandings
- They facilitate coordinated behaviour of various groups.

3.1.3 Strategies

Strategy refers to a broad based plan of action by which an organization intends to reach its objectives. In a competitive situation, due consideration should be given to external factors while formulating strategies. SWOT (strength, weakness, opportunity and threat) analysis is to be done to device the strategies for achieving the objectives. A corporate strategy is a broad based plan which takes these factors into account and provides an optimal match between the firm and its environment.

The two important activities involved in strategy formulations are praisal which includes the analysis and study of onomic, competitive, social and cultural factors to spot opportunities and anticipate threats.

(2) Corporate appraisal which involves the analysis of institutional strengths and weaknesses. The company must plan to exploit these strengths to the maximum extent.

The relationship between objectives and strategy can be illustrated with the following example.

Objective, increase rules next year by 10% over the current year figure.

Strategies

- Identify marketing efforts in domestic market (private schools).
- Expand the institution in the markets.

3.1.4 Tactics

Tactics is a means by which a strategy is implemented. A tactic is a more specific detailed course of action than the strategy. Tactics generally cover shorter time periods than strategies.

For examples

Tactics for the achieving strategy are:

(1) Advertise through the use of public address system to people.

(2) Advertise on television programme watched by the people.

To be effective, a tactic must coincide with and support the strategy with which it is related.

3.1.5 Policies

Policy is another important component of educational planning. Policy is a general guideline for decision making. It sets up boundaries around decisions.

Good policies are flexible, fairly easy to be interpreted and consistent with other policies throughout the education. There are numerous policy areas in any school e.g. personnel policies, financial policies etc.

Advantages of Policies

...decision making process

(2) ...uniformity in action in respect of various matters at various institutional points and make the actions more predictable.

(3) Policies make it easier for superior to delegate more and more authority to his subordinates.

(4) Policies give the practical shape to the objectives by directing the way in which the predetermined objectives are to be attained.

3.1.6 Procedure

A procedure is a standing plan describing a customary method of handling a future activity. A procedure provides a detailed set of instructions for performing a sequence of actions involved in doing particular work. Thus, procedure is a series of related tasks that make up the chronological sequence and the established way of performing the work to be accomplished.

3.1.7 Methods

Method is designed as a prescribed manner for performing a given task with adequate consideration to the objectives, resources available and the total expenditure of time, money and effort. It helps to discharge a particular task under given condition. Methods help in increasing the effectiveness and usefulness of the procedure. Methods can be improved from time to time.

3.1.8 Rules

The term rule is defined as a prescriptive directive to educational stakeholders on their conduct and action. Rules are detailed and recorded instructions that a specific action must or must not be performed in a giving situation.

For example, the rule can be stated as follows:

(1) Employees are to have educational background as qualification

(2) Smoking is prohibited inside the class

(3) Officers are not entitled to collect money in any form e.g levies

(4) All payments should be to the cashier.

3.1.9 Programme

as a comprehensive plan that includes future use of integrated pattern and establishes a sequence of required actions and time schedules for each in order to achieve the stated objectives.

The programme can include objectives, policies, procedures, methods schedule and budget programme outline the actions to be taken by whom, when and where.

An educational programme for example: to establish a school

Material specifications, processes to be followed, location to be used, skills to be utilized (NCE, B.Ed, M.Ed), teaching-learning (methodology, classroom) schedule to be met and the housing structure to be made for boarding students.

3.1.10 Standard

A standard is a unit of measurement established to serve as a criteria or level of reference for performance.

Standards may be established on the basis of past experience appraisal or scientific method. The scientific method uses factual data to establish carefully prescribed standards of performance. Standards also must contain some degree of flexibility to adjust to changing conditions. In an educational setting, standards are interdependent in the sense that change in one standard requires change in other standards also. That is, different standards are attained in using an NCE holder for secondary school class than a degree holder.

3.1.11 Schedules

Scheduling is a process of establishing a time sequence for the work to be done. It is an essential part of an action plan. It prescribes the exact time when each step will begin and when it would be completed. Scheduling is nothing but the time table of activities highlighting, when each activity will start and end? Where and who will do it? A tropical example of this is the school timetable or class room timetable.

3.1.12 Budget

...nent of expected – results expressed in numerical ... either in financial terms or in terms of labour hours in education, units of products, machine hours or any other numerically measurable term outside the educational situation.

Budgets may be comprehensive in that they include educational stakeholders or they can be drawn up for any segment of it. At the same time, they establish goals for each activity. Budgets always apply to a time period. Budgets are plans that are used for controlling purpose. The term budgeting designates controlling based on a budget.

4.0 CONCLUSION

Elements in educational planning are vital concepts which assist in planning and in the course of attaining the educational purpose or its goals.

5.0 SUMMARY

The elements in educational planning are: mission, objective, strategies tactics, policies, procedure, methods, rules, programmes, standard, schedules and budget.

6.0 TUTOR-MARK ASSIGNMENT

1. Discuss the following educational planning concepts: mission, objective, strategies tactics, policies, procedure, methods, rules, programmes, standard, schedules and budget.
2. Discuss the application of education planning concepts in planning Education in Nigeria.

7.0 REFERENCES / FURTHER READINGS

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MODULE 2 ; MODELS IN EDUCATIONAL PLANNING

UNIT 1 ROLES OF MODEL IN PLANNING

CONTENTS

1.0 INTRODUCTION

The roles of model in planning are the areas in an institution or educational situation where the models could be used. This unit will examine the types of models in educational planning, its scope in educational planning and the techniques.

2.0 OBJECTIVES

At the end of the unit students should be able to:

- i state the types of models in educational planning
- ii discuss the various scope of educational planning
- iii. explain the techniques of educational planning

3.0 MAIN CONTENT

3.1 MODELS IN EDUCATIONAL PLANNING

Modeling in educational planning is a systematic method for obtaining the optimal solution to problems. The researchers prepare a model representing the problem situation under review for the purpose of its application under hypothetical circumstances, thus, simulating the system. The model can be manipulated to measure the effect of changes introduced. A scientific model in educational planning is a representation of the system helps to predict the effect of possible changes in the

s substitute for the real life situation.

Generally, the following three types of models are used.

(1) Iconic (physical) models

(2) Analogue Models

(3) Mathematical models

(4) Simulation and Heuristic models

(1) Iconic Models:- Iconic model is a physical representation of the system either in idealized form or on a different scale e.g. a photograph, mode of an engine etc. Iconic means looking like the real item. Te dimensions of the models may be smaller or bigger than the real items. Iconic models are easy to build and observe but difficult to manipulate and not helpful for prediction purposes and for the study of the changes in the operation of the system. Iconic models can be constructed in three dimensions. Commonly, an iconic model represents a static event. Characteristics that are not considered in the analysis for which the model is constructed are not included in the model.

(2) Mathematical Models: In this model, the components of what is represented and their interrelationships are given by a set of mathematical symbols. A great advantage of such models is that they lend themselves easily for manipulation on computers. A symbolic or mathematical model consists of a set of equations which define and specify the relationship and interactions among various elements of decision problems under study. The solution of the problem is then obtained by applying well-developed mathematical models which have special advantages compared to other models. Transformation of a model from a verbal to a mathematical form makes greater clarification of existing and likely relationships and interactions among variables and helps easier way of communication because of common mathematical terminology and symbols.

Heuristic Models: The development of computer development of simulation and heuristic models Simulation modeling has more flexibility than mathematical model simulation models are thus used to represent complex systems which, otherwise cannot be formulated mathematically. Simulation models can not yield exact solutions. Heuristic models are essentially models that employ some intuitive rules or guidelines in the hope of generating new strategies which will yield improved solution. *Heuristic models do not give an optimal solution to the problems.* The advantage of such models is that they operate faster as compared to other models and they are very much useful for solving large scale problems.

3.2 SCOPE OF EDUCATIONAL PLANNING

Educational planning has a wider scope for applications in diversified units, section, departments or fields. Educational planning is mainly concerned with the techniques of applying scientific knowledge. It provides an understanding which gives the school or institutional administrators new insight and capabilities to determine the optimum solutions to the problems.

The various fields of application of Educational planning are:

(a) Finance and investment decision

- Cash flow analysis
- Long range capital budgeting
- Risk analysis
- Investment decisions
- Dividend policies
- Credit policies

(b) Purchasing and Material management

- Determining quantity and timing of purchase of materials, such as laboratory equipment and machinery etc
- Replacement policies

d physical distribution

(c) ... of institution

- scheduling and sequencing allocation
- Location and layout of Physical facilities
- Maintenance policies
- Project scheduling and resource
- Optimum product mix

(d) Marketing

- Student selection (mix or single sex) and strategy
- manpower planning
- Advertising and promotion strategies
- Effectiveness of marketing (awareness)

(e) Personnel

- Recruitment policies and job assignment
- Optimum mix of age of employees
- Wage and incentive system

(f) Research and Development

- Determining areas to be focused for research
- Design optimization
- Reliability and evaluation of alternative designs

(g) Health

- Sickbay: First aid box etc

3.3 TECHNIQUES OF EDUCATIONAL PLANNING

(1) Linear Programming

It is basically a resource allocation technique. An allocation problem arises whenever there are a number of activities to perform but limitation exists either on the availability of the resources or the way they are expended for performing the desired activities in the most effective way.

It is a versatile technique which can be applied to a variety of problems of management. This technique is applicable in problems characterized by the

...ecision variables, each of which can assume values ...affect the other decision variables.

The most important feature of linear programming is the presence of linearity in the problem.

The various models in linear programming are:

(a) simplex method

(b) transportation model

(c) assignment model

(2) Dynamic Programming

Dynamic programming models are used to make interrelation sequential decisions for multistage problems over a number of time periods. The underlying principle of dynamic programming model is that regardless of what the previous decisions are, it tries to determine the optimum decision for the periods that still lies ahead. The dynamic programming approach divides the problem into a number of sub-problems or stages. The decision made at each stage influences not only the next stage but also every stage of the end of the problem.

(3) Games Theory

This is a technique using logical deductions to explore the consequences of the various strategies which might be adopted by competing players. Thus, it can be used to represent the problems involved in formulating business strategies in a competitive situation. A game is specified by a set of players, a set of actions which are available to each player and the set of rewards (or pay-offs) determined by the actions which players choose to exercise. This model determines the optimum strategy.

(4) Inventory Control

Generally, the business firms must carry inventories because production and sales do not match. The business firms should hold some level of inventories of finished goods and raw materials to ensure uninterrupted supply stomers. Inventory model deals with determination (EOQ) which balances the cost of procurement and inventory carrying cost. It determines how much to order, when to order and how much to carry in stock so that total cost of inventory is minimized.

(5) Decision Theory

Most economic decisions are made under the conditions of uncertainty and these conditions are beyond the control of the decision maker e.g. pricing decisions of the competitor. Decision theory plays an important role in helping managers make better decision under uncertain future conditions. Decision theory covers three categories of decision making under uncertain future conditions.

(a) Decision making under conditions of **certainty**.

(b) Decision making under conditions of **risk**.

(c) Decision making under conditions of **uncertainty**.

(6) Replacement Model

Replacement problems are generally of two types involving replacement of items that deteriorate with time and those that do not deteriorate but suddenly fail. Example of first category is – vehicles, machines, equipments etc. The problems consist of finding an optimum time for replacement so that the sum of the cost of new equipment and cost of maintaining the efficiency of the old, meeting and cost of loss of efficiency is minimized.

The second category includes examples like electric bulbs, and transistor etc. For boarding schools, the problem here is finding which items are to be replaced and whether or not there will be group replacement and if so, when they are to be replaced.

(8) Simulation Models

Complex resource allocation problems involving probabilities elements e.g. holding of inventories and others often cannot be solved completely by excess analysis. It is possible to simulate the operation of a system to create exact model of physical system. Thus, simulation is the representation of a reality through the use of model or some other device which will reset in the

nder a given set of conditions. It is a quantitative
system by developing a model of that system and then conducting a series of organized trial and error experiments to predict the behaviour of the system overtime. Simulation is a very powerful tool and is most widely used in operations research technique.

4.0 CONCLUSION

To ensure proper educational planning process, the roles of model in planning an institution or educational programmes must be structured in models.

5.0SUMMARY

*Models in educational planning are: Iconic (physical) models, Analogue Models, Mathematical models and Simulation and Heuristic models.

*Scope of educational planning models: Finance and investment decision, Purchasing and Material management, establishment of institution, marketing, personnel, health, research and development.

*Techniques of educational planning are Linear Programming, dynamic programming, game theory, inventory control, decision theory, replacement models and simulation models.

6.0 TUTOR-MARK ASSIGNMENT

1. The techniques produce a fine frame of decision making, in theory, but yields an impracticable guide in practice. Why do you think the model will be difficult to apply in your country?

2. Some constituencies of your plural society want schools to be returned to the religious organizations that started them. What model in educational planning would you recommend for your government to resolve the issue and why?

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UNIT 2 PRINCIPLES FOR DESIGNING MODELS

CONTENT

1.0 INTRODUCTION

It is important to examine the principles of educational planning models. This unit will discuss the principles according to the following sub-topics: model principles, phases, methodology and characteristics.

2.0 OBJECTIVES

At the end of the chapter students should be able to:

i. state the educational planning system model principles models
ii discuss the different phases in educational planning models
iii. discuss the methodology of educational planning models
iv enumerate the characteristics of educational planning models

3.0 MAIN CONTENT

3.1 Model Principles

Principles are a popular way of expressing commitment to certain ideals. As used here, the principles can bring us a step closer to understanding educational sustainability. These principles offer a starting point for addressing sustainability at the educational levels, whether one uses them at presented, or interprets them so that they reflect one's educational needs in particular. They act as a touchstone for all who may be involved in educational sustainability initiatives in terms of growth and development of the economy. A suggested

…rinciples in modeling is to start by agreeing on the … suitable for education. This may not be a straightforward exercise since people tend to be careful in their choice of preferred words. Then, with the support of those who helped develop the new version of the principles, consider how to translate the broad statements used in the principles into specific actions that different sectors, organizations, even individuals, and even the community can take. For example: What can the Ministry of Education (Federal, State and Local Government levels) do in support of each principle? What about it's instructors? How about the schools and school boards in the community? What can other educational stakeholder do? What can you do in your own capacity and in your day to day activities? Going through this exercise should help make the idea of a sustainable, qualitative education more tangible. People and organizations can then see, in practical terms, actions they can take. Hopefully as a result they will more fully appreciate the need for these actions. Also included is an illustrative set of examples that highlight some possible actions related to the model principles. These are actions that might be taken by the government since she is the policy maker for public and private (*government initiative is an input for private*) schooling.

The educational planning system has the following Model Principles*:*

1. Recognizes that growth occurs within some limits and is ultimately limited by the carrying capacity of the environment;
2. Values cultural diversity;
3. Has respect for other life forms and supports biodiversity;
4. Has shared values amongst all the educational stakeholders (promoted through sustainability education);
5. Employs ecological decision-making (e.g., integration of environmental criteria into all governmental and personal decision-making processes);

plans in a balanced, open and flexible manner that ectives from the social, health, economy and institutions since this has a relationship with the environmental sectors of the community.

7. Makes best use of local efforts and resources (infrastructural, instructional and structural facilities);
8. Uses renewable and reliable sources of energy;
9. Minimizes harm to the natural environment of learner and teacher (Instructors)
10. Fosters activities which use materials in continuous cycles. And, as a result, a sustainable education:
11. Does not compromise the sustainability of future generations by its activities (a temporal perspective).

What actions can be suggested for each of the principles which could be undertaken in education?

3.2 PHASES OF EDUCTIONAL PLANINNG MODELS

The scientific approach in Educational planning models consists of the following three phases.

(i) Judgment phase
(ii) Research Phase
(iii) Action Phase

(i) Judgmental phase:- The following activities are carried out during the judgmental phase –

(a) Determination of the operation
(b) Determination of values and objectives associated with the operation
(c) Determination of measures of effectiveness
(d) Formulation of the problem relative to the objectives.

(ii) Research phase:- The research phase includes the following activities

...d data collection to understand the problem in a

(b) Formulation of the hypothesis and model

(c) Testing of the hypothesis and analysis of the available data

(d) Prediction of results from the hypothesis

(e) Generalization of results and consideration of alternative methods.

(iii) **Action Phase:** This phase is mainly the recommendation phase. This recommendation consists of a clear statement of the assumptions made, scope and limitations of each alternative and also the preferred course of action.

3.3 METHODOLOGY OF EDUCATIONAL PLANNING MODEL

The systematic methodology developed for educational planning model deals with problems involving conflicting and multiple objectives, alternatives and policies. The various steps in educational planning model methodology are:

(1) Problem Formulation

This is an important phase in which the educational planners team should formulate the management problem and then translate the problem into a research problem, through analysis of the environment, functions, communication, control of system, policies and objectives of the institution.

(2) Construction of the mathematical model

(a) Determination of decision variable

(b) Determination of the problem parameters (constraints imposed on the problem)

(c) Formulation of the objective function

(d) Constraint's equation (Physical limitations on the set of decision variables).

(3) Deriving the solution from the model

(4) Testing the model

(5) Installing the controls over the solution

(6) Implementation of the solution.

OF EDUCATIONAL PLANNING MODEL

(1) … ning model is the interdisciplinary approach consisting of experts from different disciplines to obtain an optimal solution to the problem.

(2) Educational planning model uses scientific methods established by research to reach the optimum solution

(3) Educational planning model provides the quantitative basis for managerial decision making.

(4) It takes into account the aspects of the problem (holistic approach)

(5) Educational planning model examines all the functional relationships in a system.

(6) Educational planning model cannot give a perfect solution to the problem. It improves the quality of the solution

(7) Educational planning model gives the optimal solution i.e. the one best solution under given condition. The solution changes with change in conditions.

4.0 CONCLUSION

Principles can bring us a step closer to understanding educational sustainability. These principles offer a starting point for addressing sustainability at the educational levels. Whether you use them as presented, or interprets them so that they reflect your educational needs in particular. This could be attained through educational planning system model principles models, phases in educational planning models, methodology of educational planning models and its characteristics.

5.0 SUMMARY

*Educational planning system model principles models are:

Recognizes that growth occurs within some limits and is ultimately limited by the carrying capacity of the environment; values cultural diversity; respect for other life forms and supports biodiversity; shared values amongst all the romoted through sustainability education); employs (e.g., integration of environmental criteria into all governmental and personal decision-making processes etc

*Phases in educational planning models are judgment, research and action Phases

*Problem Formulation, Construction of the mathematical model, deriving the solution from the model, testing the model, installing the controls over the solution, Implementation of the solution were the methodology of educational planning models.

6.0 TUTOR-MARK ASSIGNMENT

1. State the Principles of Educational planning model in Nigeria.
2. Design a model for the Educational System of Nigeria, with special reference to the necessary principles.

7.0 REFERENCES / FURTHER READINGS

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UNIT 3 USES OF MODELS IN EDUCATIONAL PLANNING

1.0 INTRODUCTION

Educational modeling takes different forms which could serve the purpose it is meant. This unit examines the mathematical preliminaries and its use in models in educational planning

2.0 OBJECTIVES

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

i. list various mathematical preliminaries used in educational planning

ii. discuss the various ways by which mathematical preliminaries could be used in educational planning model

3.0 MAIN CONTENT

3.1 Models and Mathematical Preliminaries

Application of mathematical programming is to construct deterministic models, principally for business and economics. This is also applicable to the educational sectors. For models that only require linear algebraic equations, the techniques are called linear programming; for models that require more complex equations, it is called nonlinear programming. In either case, models frequently involve hundreds or thousands of equations. The discipline emerged during World War II to solve large-scale military logistics problems. Mathematical programming is also used in planning civilian production and transportation schedules and in calculating economic growth.

...pts to optimize, maximize or minimize an objective ...g resource constraints; also known as mathematical programming. Optimization models include Linear Programming (LP), Integer Programming and Zero-One Programming. Others are decision theory in mathematics and statistics is concerned with identifying the values, uncertainties and other issues relevant in a given decision and the resulting optimal decision. It is sometimes called game theory.

3.2 USES OF MODELS

Finance: The capital asset pricing model uses linear regression as well as the concept of Beta for analyzing and quantifying the systematic risk of an investment. This comes directly from the Beta coefficient of the linear regression model that relates the return on the investment to the return on all risky assets.

Research Purpose: Teaching-learning situation and teaching resources; Mixed models are widely used to analyze linear regression relationships involving dependent data when the dependencies have a known structure.

Course of study: Linear regression is widely used in biological, behavioral and social sciences to describe possible relationships between variables. It ranks as one of the most important tools used in these disciplines.

In the real sense of it, models in education planning are applicable in the following areas: **Decision making, Educational planning, Projections, developing mathematical models, school demography**, etc

4.0 CONCLUSION

The use of models can be applicable to virtually all aspect of Educational planning models. All the educational stakeholders are also users of models in Educational Planning.

aspects surrounding the planning, accessing, and projecting in the educational system.

6.0 TUTOR-MARK ASSIGNMENT

1. Enumerate other sections in educational planning process in which models can be used?

2. Analyse the use of models in the following section in educational planning process: Decision making, Educational planning, Projections, developing mathematical models, school demography.

7.0 REFERENCES / FURTHER READINGS

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UNIT 4 LINEAR PROGRAMMING PROBLEM I

CONTENTS

1.0 INTRODUCTION

Linear programming is a mathematical technique for determining the optimal allocation of the resources and obtaining a particular objective when there are alternative uses of resources. This unit examines the model in application to education.

2.0 OBJECTIVES

At the end to this unit, students should be able to:

i. define linear model.
ii. state standard form of linear programming problem.
iii. assumptions underlining linear model.
iv. estimation methods.

3.0 MAIN CONTENT

3.1 WHAT IS LINEAR MODEL?

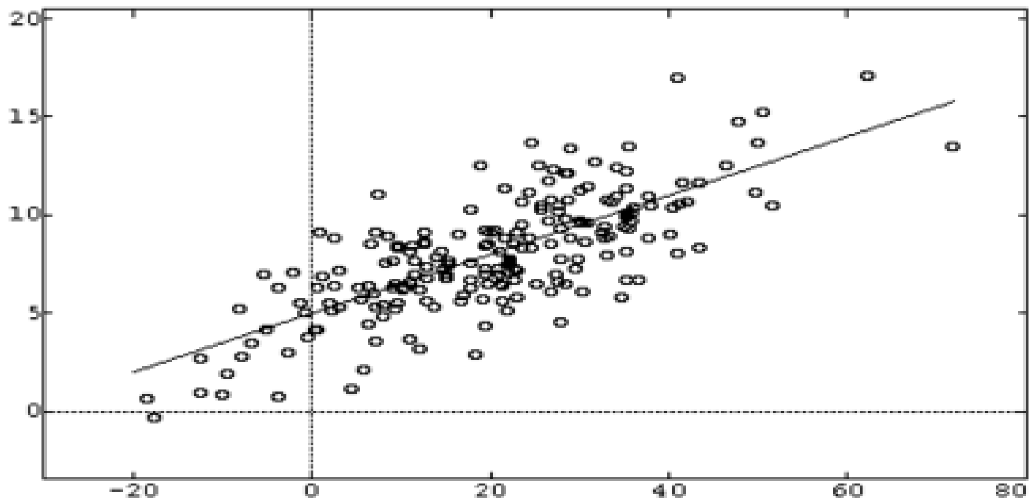
Linear regression refers to any approach to linear modeling the relationship between one or more variables denoted y and one or more variables denoted X, such that the model depends linearly on the unknown parameters to be estimated from the data. Such a model is called a "linear model." Most commonly, linear regression refers to a model in which the conditional mean of y given the value of X is an affine function of X. Less commonly, linear regression could refer to a model in which the median, or some other quartile tion of y given X is expressed as a linear function of ression analysis, *linear regression* focuses on the conditional probability distribution of y given X, rather than on the joint probability distribution of y and X, which is the domain of multivariate analysis. Linear regression was the first type of regression analysis to be studied rigorously, and to be used extensively in practical applications. The reason for this is that models that depend linearly on their unknown parameters are easier to fit than models that are related non-linearly to their parameters and the statistical properties of the resulting estimators are easier to determine. Linear regression has many practical uses. Most applications of linear regression fall into one of the following two broad categories:

If the goal is prediction, or forecasting, linear regression can be used to fit a predictive model to an observed data set of y and X values. After developing such a model, if an additional value of X is then given without its accompanying value of y, the fitted model can be used to make a prediction of the value of y.

If we have a variable y and a number of variables X_1, ..., X_p that may be related to y, we can use linear regression analysis to quantify the strength of the relationship between y and the X_j, to assess which X_j may have no relationship with y at all, and to identify which subsets of the X_j contain redundant information about y, so that once one of them is known, the others are no longer informative.

Linear regression models are often fit using the least squares approach, but may also be fit in other ways, such as by minimizing the "lack of fit" in some other norm, or by minimizing a penalized version of the least squares loss function as in ridge regression. Conversely, the least squares approach can be used to fit models that are not linear models. Thus, while the terms "least squares" and *linear model* are closely linked, they are not synonymous.

Linear regression



Example of linear regression with one independent variable.

The objective may be cost minimization or profit maximization. In practice, linear programming is one of the powerful techniques for managerial decision making. The application of this technique has helped to solve many complex problems which otherwise are more difficult to solve. The specific problems where this technique can be successfully applied are:

- Production scheduling
- Capital budgeting
- Resource allocation and optimal utilization of resource
- Product mix decisions

3.2 STANDARD FORM OF LINEAR PROGRAMMING PROBLEM

Let x_1 x_2 x_3 .... x_n are the decision variables Optimize (maximize or minimize)

$Z - c_1 x_1 + c_2 x_2 + ... + c_n x_n$ (objective function).

Subject to the constraints:

$a_{11} x_1 \ a_{11} x_2 + ... + a_{1n}x_n \leq b_1$

$a_{21} x_1 \ a_{22} x_2 + ... + a_{2n}x_n \leq b_2$

$a_{m1} x_1 \ a_{m2} x_2 + ... + am_nx_n \leq b_n$

$x_1 \ x_2$ ...... $x_n > 0$ (non negative restriction)

$c_1 \ c_2$ ...... c_n are cost or profit coefficients

A_u (i – 1, 2 .... N, j = 1, 2 ...... n) are structural coefficients b_1, b_2 ..... b_n are called requirements or availability.

The LPP can be solved by two methods

(i) Graphical method: It is used only when two decision variables are involved. This is more simple.

(ii) Simplex method: This is useful for any number of decision variables in the problem and there are number of constraints on the problem.

3.3 ASSUMPTIONS: Two key assumptions are common to all estimation methods used in linear regression analysis:

The design matrix *X* must have full column rank *p*. Otherwise the parameter vector β will not be identified — at most we will be able to narrow down its value to some linear subspace of. For this property to hold, we must have ple size. Methods for fitting linear models with $p > n$ t require additional assumptions such as "effect sparsity" — that a large fraction of the effects are exactly zero.

The regressors x_i are assumed to be error-free, that is they are not contaminated with measurement errors. Although not realistic in many settings, dropping this assumption leads to significantly more difficult errors-in-variables models. Beyond these two assumptions, several other statistical properties of the data strongly influence the performance of different estimation methods:

Some estimation methods are based on a lack of correlation, among the n observations. Statistical independence of the observations is not needed, although it can be exploited if it is known to hold.

The statistical relationship between the error terms and the regressors plays an important role in determining whether an estimation procedure has desirable sampling properties such as being unbiased and consistent. The variances of the error terms may be equal across the n units (termed *homoscedasticity*) or not (termed *heteroscedasticity*). Some linear regression estimation methods give less precise parameter estimates and misleading inferential quantities such as standard errors when substantial heteroscedasticity is present. The arrangement, or probability distribution of the predictor variables x has a major influence on the precision of estimates of β. Sampling and design of experiments are highly-developed subfields of statistics that provide guidance for collecting data in such a way to achieve a precise estimate of β.

3.4 Estimation methods

Numerous procedures have been developed for parameter estimation and inference in linear regression. These methods differ in of algorithms, presence of a closed-form solution, to heavy-tailed distributions, and theoretical assumptions needed to validate desirable statistical properties such as consistency and asymptotic efficiency. In general, the more restrictive non-parametric assumptions may be imposed on the distribution of error terms, the more challenging it becomes to construct an efficient estimator which would use all the available information. Some of the more common estimation techniques for linear regression are summarized below.

Ordinary Least Squares (OLS) is the simplest and thus very common estimator. Generalized Least Squares (GLS) is an extension of the OLS method, which allows efficient estimation of β when either heteroscedasticity, or correlations, or both are present among the error terms of the model, as long as the form of heteroscedasticity and correlation is known independently of the data. Iteratively reweighted least squares (IRLS) is used when heteroscedasticity, or correlations, or both are present among the error terms of the model, but where little is known about the covariance structure of the errors independently of the data[7]. In the first iteration, OLS, or GLS with a provisional covariance structure is carried out, and the residuals are obtained from the fit.

Others are Least absolute deviation (LAD) regression is a robust estimation technique in that it is less sensitive to the presence of outliers than OLS (but is less efficient than OLS when no outliers are present). Principal component regression (PCR) is used when the number of predictor variables is large, or when strong correlations exist among the predictor variables. Total least squares (TLS) is an approach to least squares estimation of the linear regression model that treats the covariates and response variable in a more geometrically symmetric manner than OLS. It is one approach to handling the "errors in variables" problem, and is sometimes used when the covariates are assumed to be error-free. "Least angle regression" is an linear regression models that was developed to covariate vectors, potentially with more covariates than observations etc.

4.0 CONCLUSION

Linear regression models have been examined as the fit using the least squares approach. There are some certain constraints that need to be considered in planning process. The LPP can be solved by two methods: Graphical method and Simplex method:

5.0 SUMMARY

*Linear model is the relationship between one or more variables denoted by letters *y* and one or more variables denoted *x*, such that the model depends linearly on the unknown parameters to be estimated from the data.

*Standard form of linear programming problem

Let $x_1 \; x_2 \; x_3 \ldots\ldots\ldots\ldots x_n$ are the decision variables Optimize (maximize or minimize)

$$Z - c_1 x_1 + c_2 x_2 + \ldots\ldots\ldots + c_n x_n \qquad \text{(objective function).}$$

Subject to the constraints:

$$a_{11} x_1 \;\; a_{11} x_2 \; + \ldots\ldots + \; a_{1n}x_n \;\; \leq \;\; b_1$$

$$a_{21} x_1 \;\; a_{22} x_2 \; + \ldots\ldots + \; a_{2n}x_n \;\; \leq \;\; b_2$$

$$a_{m1} x_1 \;\; a_{m2} x_2 \; + \ldots\ldots + \; am_nx_n \;\; \leq \;\; b_n$$

$x_1 \; x_2 \; \ldots\ldots \; x_n > 0$ (non negative restriction)

$c_1 \; c_2 \; \ldots\ldots \; c_n$ are cost or profit coefficients

A_u (i – 1, 2 .... N, j = 1, 2 ...... n) are structural coefficients b_1, b_2 ..... b_n are called requirements or availability.

* There are two methods of LPP. They are graphical method and simple method

6.0 TUTOR-MARK ASSIGNMENT

ith relevant graphical illustrations and state ar programming Problem

2. State the assumptions underlining linear model with the appropriate estimation methods.

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UNIT 5 LINEAR PROGRAMMING PROBLEM II (GRAPHICAL METHOD)

CONTENTS

1.0 INTRODUCTION

This unit will examine the use of linear programming problem using graphical method to solve problems. The unit will identify the required region as solution to the problem.

2.0 OBJECTIVES

At the end to this unit, students should be able to:

i. illustrate linear programming problem graphically
ii. consider the assumption underlining linear model
iii. state the region that provides solution to the problem

3.0 MAIN CONTENT

3.1 Resolve using the Graphical Method the following problem:

Maximize $Z = f(x, y) = 3x + 2y$

subject to:

$2x + y \leq 18$

$2x + 3y \leq 42$

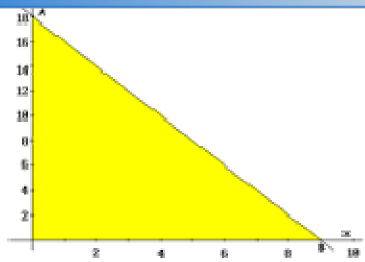
$3x + y \leq 24$

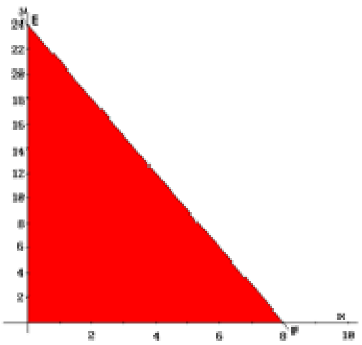
$x \geq 0$, $y \geq 0$

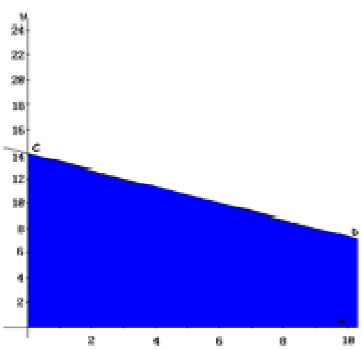
Initially we draw the coordinate system correlating to an axis the variable x, and the other axis to variable y, as can see in the figure below.

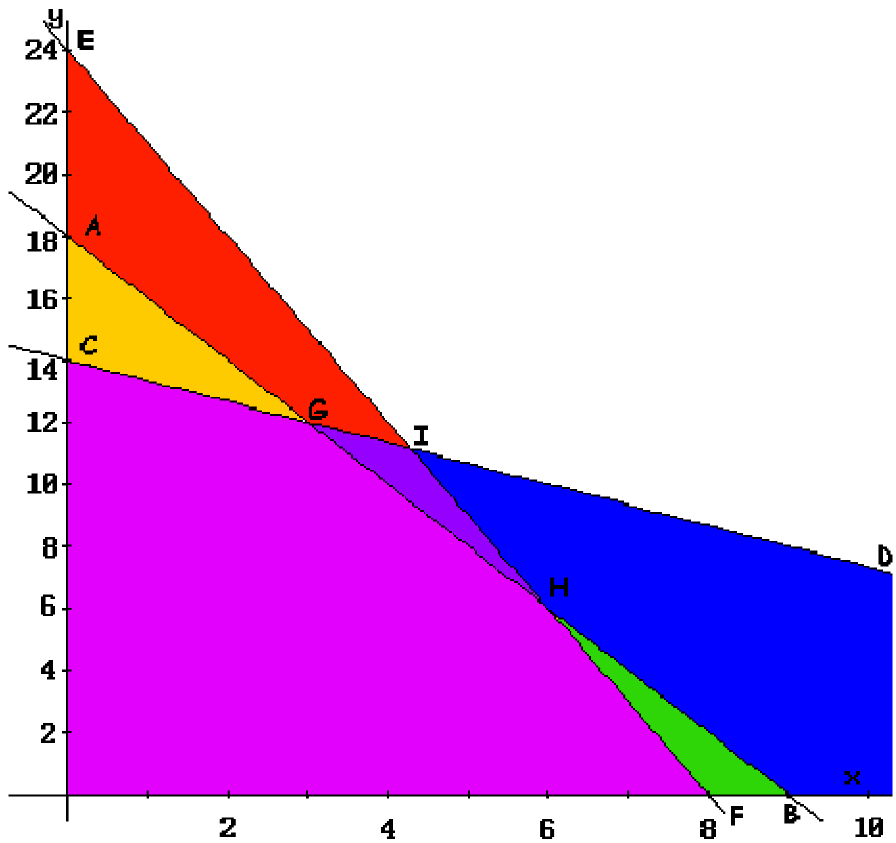
In this book, mark in them a numerical scale adapted according to the journeys of variables relating to the restrictions of the problem. Next step is draw restrictions. Beginning with the first, we draw the straight line that is obtained when the restriction regard as equality. Appear represented like the segment that joins A with B and the region that this restriction delimits is indicated for the YELLOW colour. This process is repeated in the same way with the second and further restrictions, and they delimit the BLUE and RED region respectively. The feasible region is the intersection of regions delimited by the restrictions and for the conditions of no negativeness of variables, that is, for the region of admissible values limited by both coordinated axes. The feasible region is represented for the convex polygon O-F-H-G-C, emergent of VIOLET colour.

3.2 THE GRAPH









1. Due to the feasible region is not empty (feasible problem), we proceed to determine his extreme points, candidates to optimal solutions, that are the O-F-H-G-C points figure's. Finally, we evaluate the objective function (3x + 2y) at those points, which result is picked up in the following board. As G point provides the bigger value to the objective Z, such point constitutes the optimal solution, we will indicate x = 3; y = 12, with optimal value Z = 33.

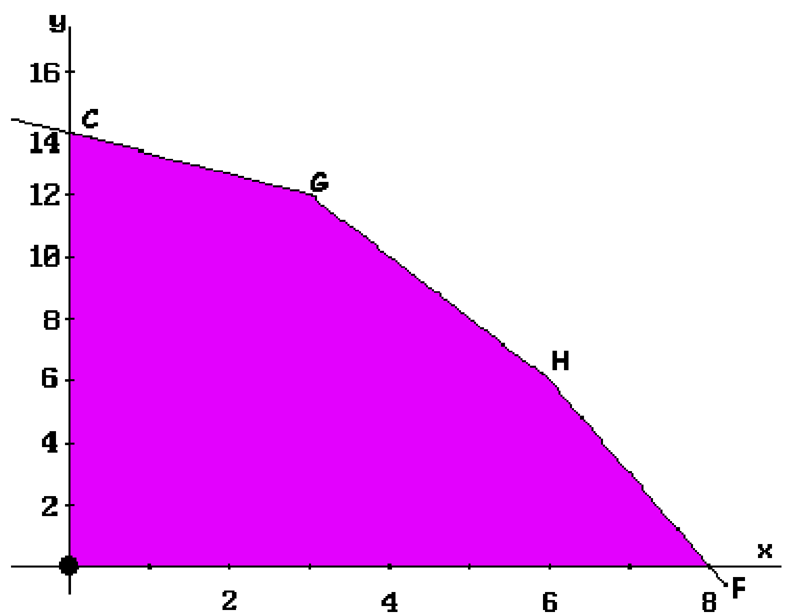
[illegible]	[illegible]nates (x ,y)	Objective value(Z)
O	(0,0)	0
C	(0,14)	28
G	(3,12)	33
H	(6,6)	30
F	(8,0)	24

3.3 COMPARING: GRAPHICAL METHOD VS. SIMPLEX METHOD

The successive boards that we have built during the simplex method provide us the value of the objective function at different vertices, fitting up, at the same time, the coefficients of initial and slack variables.

oard I) have remained all the equal coefficients, has
e function value at the vertex (0,0) that is the value which belong to the basic variables, been 0 the result.

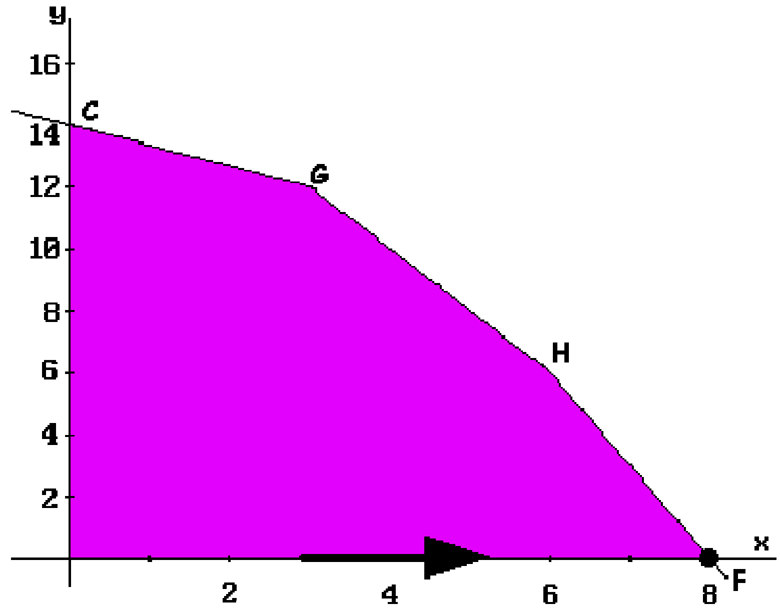
Board I . 1st iteration							
			3	2	0	0	0
Base	**Cb**	**P0**	**P1**	**P2**	**P3**	**P4**	**P5**
P3	0	18	2	1	1	0	0
P4	0	42	2	3	0	1	0
P5	0	24	**3**	1	0	0	1
Z		0	-3	-2	0	0	0



Now, it moves through the edge (0,0) F, estimating the value of the Z function, until get to F. This step is translated like the second repetition in the Simplex Method, contributing the II Board, in which have been calculated the value corresponds to the vertex F(8,0): Z=f(8,0)=24.

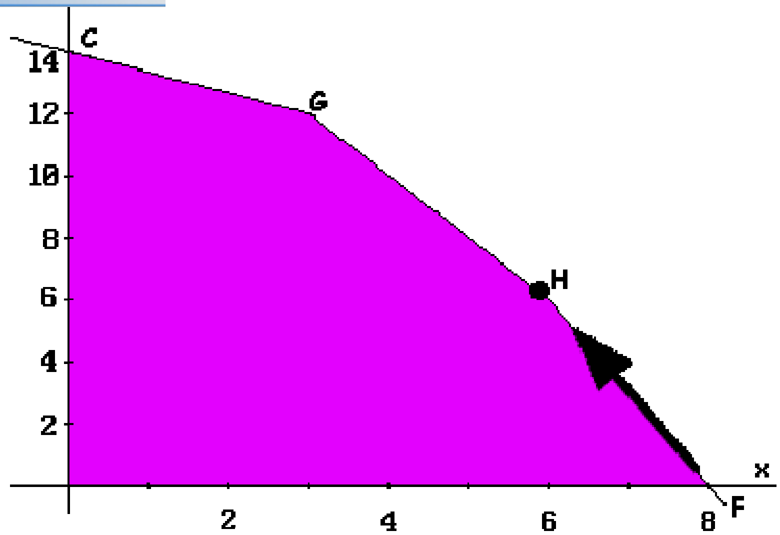
Board II . 2nd iteration

			3	2	0	0	0
		P0	**P1**	**P2**	**P3**	**P4**	**P5**
P3	0	2	0	**1/3**	1	0	-2/3
P4	0	26	0	7/3	0	1	-2/3
P1	3	8	1	1/3	0	0	1/3
Z		24	0	-1	0	0	1



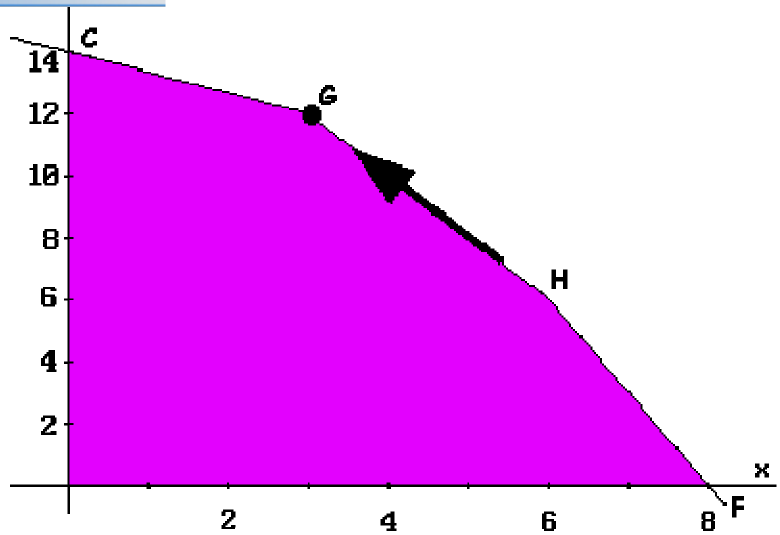
Keeps on for the FH edge, until arrive to H, where it stops and diplays the data from III Board. At this third iteration has been calculated the value that corresponds to the vertex H(6,6): Z=f(6,6)=30.

Board III . 3rd iteration							
			3	2	0	0	0
Base	**Cb**	**P0**	**P1**	**P2**	**P3**	**P4**	**P5**
P2	2	6	0	1	3	0	-2
P4	0	12	0	0	-7	1	**4**
P1	3	6	1	0	-1	0	1
Z		30	0	0	3	0	-1



We keep on doing calculations trough the HG edge, until the G vertex. The data that is reflected belong to IV Board, concluding with the same and warning that it has ended up (checking before that the solution does not get better when it moves around the GC edge).

Board IV . 4th iteration							
			3	2	0	0	0
Base	**Cb**	**P0**	**P1**	**P2**	**P3**	**P4**	**P5**
P2	2	**12**	0	1	-1/2	0	0
P5	0	3	0	0	-7/4	0	1
P1	3	**3**	1	0	-3/4	0	0
Z		**33**	0	0	5/4	0	0



The maximum value for the objective function is 33, and corresponds to x = 3 and y = 12 (vertex G). Besides, it can be checked than the value of the function at vertex C (0,14), doesn't surpass 33.

4.0 CONCLUSION

This unit has been able to solve linear programming problem using graphical method. Through this we have been able to identify the required region as solution to the problem. We have also been able to comparing graphical method and simplex method.

5.0 SUMMARY

Graphical method is another method which can be used to solve linear programming problems.

6.0 TUTOR-MARK ASSIGNMENT

tems of linear constraints into systems in which all ables are either linear equations with nonnegative RHS constants, or bounds on individual variables. In each exercise give the expression for each new variable introduced, in terms of the original variables.

(i): $2x_2 - 3x_1 - 17x_3 \geq -6$

$-18x_2 + 7x_4 + 2x_3 \leq -7$

$2x_4 + 8x_3 - 4x_1 - 5x_2 \geq 2$

$-3x_3 + 2x_4 + x_1 \geq 0$

$x_1 - x_2 + x_3 - 4x_4 = -2$

$-2 \leq x_1 \leq 6,\ x_2 \geq 0,\ x_3 \leq 0.$

(ii): $x_1 + x_2 - x_3 - x_4 \geq 8$

$x_1 - x_2 - x_3 + x_4 \leq 16$

$10 \leq x_1 + x_2 + x_3 + x_4 \leq 20$

$-3 \leq -x_1 + x_2 - x_3 + x_4 \leq 15$

$x_1 \geq 6,\ x_2 \leq 7,\ x_3 \geq 0,\ x_4 \leq 0.$

(iii): $-20 \leq x_1 - x_2 - x_3 - x_4 \leq -10$

$-x_1 + x_2 + x_3 - x_4 \geq -6$

$x_1 + x_2 + x_3 + x_4 \leq 100$

$2x_1 - 3x_2 + 9x_3 = 30$

$4 \leq x_2 \leq 10;\ x_3, x_4 \geq 0.$

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UCATIONAL MODELS

UNIT 1 ASSIGNMENT MODEL

1.0 INTRODUCTION

In assignment models, the objective is to assign the number of resources (men, machines etc.) to the equal number of jobs at a minimum cost. This chapter examines the model in term of assumption, its mathematical statement, the Hungarian method and the maximization assignment problem

2.0 OBJECTIVES

At the end of this chapter, students should be able to:

i. define assignment model
ii. state the assumptions
iii. state the mathematical statement of the problem
iv. hungarian method for solving assignment problem
v. maximization assignment problem

3.0 MAIN CONTENT

3.1 DEFINE ASSIGNMENT MODEL

Assignment model is a special case of transportation problem in which the objective is to assign a number of origins to equal number of destinations at a minimum cost. In this problem, the facilities represent the sources, while the jobs represent the destinations. The supply available at each source is 1 (i.e. ai – 1 for all i) similarly, the demand at each destination is 1 i.e. = bj for all j. The cost of assigning facility to job is Cij.

Jobs

	1	2	-	n	Supply
1	C_{11}	C_{12}	…	C_{1N}	1 ai
2	C_{21}	C_{22}	…	C_{2N}	1
. . . .	. . .	. . .	. . .	. . .	- . . . . .
m	C_{m1}	C_{m2}	. . .	C_{mn}	1
Demand bj	1	1	.	1	

3.2 ASSUMPTIONS

The assignment is to be made on one to one basis. The problem can be stated as:

There are n'jobs and these 'n' jobs are to be processed on available machines. Cij represents the cost of assigning the job 'i' to the machine 'j'. The assignment of the jobs is made in such a way that each job should be allocated to only one machine. The problem iks to determine the best assignment of jobs to machines (jobs to resources) that result in minimum total cost of processing.

(1) Only one job should be allocated to each worker.

(2) Jobs differ in their work contents and workers differ in their capabilities.

(3) The cost of processing each job on each of the worker (cij) is known.

3.3 MATHEMATICAL STATEMENT OF THE PROBLEM

$$\text{Minimize } Z = \sum_{i-1}^{n} \sum_{j-1}^{n} Cij \ Xij$$

i = 1, 2, ……….. n

j = 1, 2, ……….. n

subjected to the following restrictions

Xij = 0 if the i^{th} job is not assigned to j^{th} machine

1 if the i^{th} job is assigned to j^{th} machine.

$$\sum_{i-1}^{n} Xij = 1 \qquad j = 1, 2, \ldots\ldots\ldots n$$

Only one person should be assigned to j^{th} job.

$$\sum_{j-1}^{n} Xij = 1 \qquad j = 1, 2, \ldots\ldots\ldots n$$

(Only one job is doen by j^{th} person)

3.4: HUNGARIAN METHOD FOR SOLVING ASSIGNMENT PROBLEM

Step 1: Subject the minimum cost of each row of the cost matrix from all the other elements of respective rows.

Step 2: In reduced matrix of step 1 subtract minimum cost of each column of the cost matrix from all the other elements of the respective column.

Step 1 and 2 will result in minimum one zero in each row and column.

n number of horizontal and vertical lines to cover all

Let 'N' be the minimum number of liens to cover all zeros.

(i) If N = n the order of the matrix (number of rows or columns) make the zero assignments to get the solution.

(ii) If N < n, then proceed to step 4.

Step 4: Determine the smallest cost element in the matrix not covered by 'N' lines. Subtract this element form all the elements which are not covered by the lines and add this elements at the junction of (Intersection) horizontal and vertical lines. The second modified matrix is obtained.

Step 5: Repeat step 3 and 4 until minimum number of lines to cover all zeros will be equal 'N' (Number of rows or column)

Step 6: Procedure to make zero assignment.

- Examine the rows until a row which has single zero is found. Mark the row by a square □ to indicate the assignment.
- Mark a cross (x) over all zeros lying in the column of the marked row which indicate that no other zero is considered for future assignment.
- Continue in this manner until all rows have been examined.
- Repeat the same procedure for columns also.

Step 7: Repeat step 6 until the following situation occurs.

(i) No unmarked zero is left

(ii) There are more than one unmarked zeros in the one column or row.

In case 2 Mark □ one of the unmarked zeros arbitrarily and marked (x) in cells containing remaining zeros in its row or column.

Repeat this step until no unmarked zero is left in the matrix.

Step 8: The exactly one marked □ zero in each column and each row is obtained.

The assignment corresponding to marked □ zeros will give the optimal assignment.

Procedure to draw minimum number of lines to cover all zeros.

for which no assignment is made

(ii) Mark (√) the columns (not already marked) which have zeros in the marked rows.

(iii) Mark (√) rows (not already marked) which have assignments in marked columns.

(iv) Repeat steps (ii) and (iii) until no more markings are possible.

(v) Draw the lines through all unmarked rows and through marked columns.

This gives the minimum number of lines to cover all zeros.

Problem: Different jobs are to be done on 4 different worker. The matrix below gives the costs (in Rs) of producing each job i on each one of the machines 'j'. How jobs should be assigned to the machine so that the total cost: is minimum

	Machines			
Jobs	**A**	**B**	**C**	**D**
Jl	5	7	11	6
J2	8	5	9	6
J3	4	7	10	7
J4.	10	4	8	3

Solution:

(1) Row Operation: Select the smallest element from each row and subtract it from all other elements from that row. Resulting matrix is

	A	**B**	**C**	**D**
J1	0	2	6	1
J2	3	0	4	1
J3	0	3	6	3
J4	7	I	5	0

Select the smallest element in each column and other elements of the column. The reduced matrix after column operation is

	A	B	C	D
J1	0	2	2	1
J2	3	0	o	1
J3	7	2	2	3
J4	7	1	0	

(3) Make the assignments and draw the minimum number of lines of connect all zeros. As the number of lines required to connect all zeros (N) is less than number of rows or columns. Then Proceed further to Step 4.

(4) Select the smallest clement not covered by lines and subtract It from all the other elements which are not covered-by lines and this element at the intersection of horizontal and vertical lines. Other elements will remain unchanged. The modified matrix is shown below:

	A	B	C	D
J1	0	1	1	0
J2	4	0	0	1
J3	0	2	1	2
J4	8	1	1	0

Since (N = 3) < no. of rows or columns.

Repeat Step 4

The resulting matrix after the repetition of step 4 is below

	A	B	C	D
J1	0	0	0	0
J2	5	0		2
J3		1	0	1
J4	8	0	0	0

Minimum 4 lines are required to connect all Zero

Therefore N= n (no. of rows or columns)

ned.

The optimal assignment is:

Assignment	Cost
J1 – A	5
J2 – B	5
J3 – C	10
J4 – D	3
	23

Total cost of assignment = Rs. 23

3.5 MAXIMIZATION ASSIGNMENT PROBLEM

Maximization problem can be converted into a minimization problem by multiplying element of the matrix by -1 (or subtracting all the elements of the matrix from the large elements in the matrix). Then the problem is solved using Hungarian Method.

Problem. A company wishes to assign 4 salesmen to 4 districts. The volume of sales mat is given below. Make the optimal assignment which results in maximum volume of sales.

	District			
Salesman	**A**	**B**	**C**	**D**
1	250	300	420	400
2	350	400	200	250
3	500	375	400	350
4	400	350	420	300

Solution: Convert the problem into minimization problem by subtracting all the elements in the problem by the largest element in the matrix. The resulting matrix is,

	A	B	C	D
1	250	200	80	100
2	150	100	300	250
3	0	125	100	150
4	100	150	80	200

Performing row operating, the resulting matrix is.

	A	B	C	D
I	170	120	0	20
2	50	0	200	150
3	0	125	100	150
4	20	70	0	120

Performing column operation, the resulting matrix is,

	A	B	C	D
1	170	120	H	0
2	50	0	200	130
3	0	125	100	130
4	20	70	0	100

otal sales are given below.

Salesmen	Districts	Sales Volume
1	D	400
2	B	400
3	A	500
4	C	420
		1720 Units

4.0 CONCLUSION

In assignment models, the objective is to assign the number of resources (men, machines etc.) to the equal number of jobs at a minimum cost. It is obvious that assignment model is applicable in educational planning model to solve problems in education using methods like Hungarian.

The assumptions are factors to consider in the course of solving problems.

5.0 SUMMARY

*In assignment models, the objective is to assign the number of resources

*The assumptions

*state the mathematical statement of the problem

Minimize Z =

i = 1, 2, ... n

j = 1, 2, ... n

subjected to the following restrictions

Xij = 0 if the i^{th} job is not assigned to j^{th} machine

1 if the i^{th} job is assigned to j^{th} machine.

assigned to j^{th} job.

person)

*There are eight steps to follow in the hungarian method for solving assignment problem.

6.0 TUTOR-MARK ASSIGNMENT

1. State the assumptions guiding the Assignment problem
2. Using the mathematical statement, the hungarian method for solving Assignment problem
3. What do you understand by maximization assignment problem?

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ION PROBLEM I

CONTENTS

1.0 INTRODUCTION

The transportation of distribution problems deal with the supply of products from factories located at different places (origins or source) to warehouses (destinations) also situated at different places at a minimum cost (or time). It depends on the capacities of the factories (sources) and the requirements (demand) of the warehouses.

2.0 OBJECTIVES

At the end of this chapter, students should be able to:

i. state the mathematical formula of transportation problem

ii state the procedure to solve the transportation problem

iii. state the basic feasible solution

3.0 MAIN CONTENT

3.1 MATHEMATICAL FORMULATION OF TRANSPORTATION PROBLEM

Let there b 'm' sources and 'n' destinations. Let 'a_1' be the no of supply units available at source (i = 1, 2, .. n) and let 'b_j' be the number of demand units required at destination j (j = 1, 2, 3 …. N). let 'C_{ij}' represent the unit transportation cost for transporting the units form source i to destination j.

The objective here is to determine the number of units to be transported from source i to destination j so that the total transportation cost is minimum along with satisfying the supply and demand conditions at source and destination respectively.

Let 'x_{ij}' represent the number of units shipped from source i to destination; and 'x_{ij}' $\geq$ 0. The problem can be stated as:

$$\text{Minimize } Z = \sum_{i-1} \sum_{j-1}^{n} Xij\ Cij$$

Subject to $\sum_{j-1}^{n} X_{ij} = n_{j'} \qquad i = 1, 2 \ldots\ldots\ldots m$

$$\sum_{i-1}^{n} X_{ij} = b_{j'} \qquad j = 1, 2 \ldots\ldots\ldots n$$

Where $X_{ij} \geq 0$.

The two constraints will be consistent i.e. the system will be in balance if

$$\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} bi$$

Thus, if the above condition is satisfied, it is called the "balanced transportation problem"

If $\qquad \sum_{i=1}^{m} a_i = \sum_{j=1}^{n} bi$

It is referred to as "unbalanced" transportation problem.

3.2 PROCEDURE TO SOLVE THE TP

Step I: Construct a transportation model

Step II: Find Basic Feasible Solution (BFS)

Step III: Perform optimality test

Step IV: Iterate towards optimal solution

Step V: Check for optimality

3.3 BASIC FEASIBLE SOLUTION

An initial Basic Feasible Solution exists for a transportation problem if the sum of origin capacities equals the sum of destination capacities. Any feasible solution satisfying m + n – 1 of the m + n constraints will automatically satisfy the last constraint. Here 'm' refers to number of sources and 'n' number of destinations. This means that one of the m + n constraints is redundant one and hence can be deleted.

This also means that a feasible solution to TP can have at the most m + n – 1 strictly positive allocation otherwise the solution will degenerate. It is

Basic Feasible Solution to a TP in such a manner
…and and supply are satisfied.

Methods to obtain BFS are:

(i) North – West Corner Rule (NWCR)

(ii) Vogels Approximation Method (VAM)

4.0 CONCLUSION

Transportation of distribution problems deal with the supply of products from factories located at different places (origins or source) to warehouses (destinations) also situated at different places at a minimum cost (or time) used in educational planning analysis.

5.0 SUMMARY

*It is a mathematical model

*There are five procedures associated to transportation problem

*The basic feasible solution are North – West Corner Rule (NWCR) and Vogels Approximation Method (VAM)

6.0 TUTOR-MARK ASSIGNMENT

1. What do you understand by transportation model?
2. State the procedures associated to the model
3. Mention the two types of methods used in transportation model.

7.0 REFERENCES / FURTHER READINGS

Ascott, Elizabeth. 2006. Benefit Cost Analysis of Wonderworld Drive Overpass in San Marcos, Texas. Applied Research Project. http://ecommons.txstate.edu/arp/104/

Michael Meyer, Eric J Miller, (2000). *Urban Transportation Planning*, McGraw-Hill, 2nd edition.

ION PROBLEM I I (North-West rule model)

1.0 INTRODUCTION

This is another method used to solve educational problem especially in planning in the educational sector. This unit will itemize the steps that are necessary in order to be able to solve problem and planning.

2.0 OBJECTIVES

At the end of this chapter students should be able to:

i. state the basic feasible solution to follow in using North-West Method

ii. apply the method in solving educational problems

3.0 MAIN CONTENT

3.1 North West-Corner Method

The method starts at the northwest-corner cell (route) of the table:

(i) Allocate as much as possible to the selected cell and adjust the associated amounts of supply and demand by subtracting the allocated amount.

(ii) Cross out the row or Column with zero supply or demand to indicate that no further assignments can be made in that row or column. If both a row and a column net to zero simultaneously, cross out one only and leave a zero supply (demand in the uncrossed-out row (column).

(iii) If exactly one row or column is left uncrossed out, stop .otherwise, move to the cell to the right if a column has just been crossed out or below if a row has been crossed out.

3.2 North – West Corner Rule

Steps to get the initial Basic Feasible Solution are as follows:

Step 1: The first assignment is made in the cell occupying the upper left hand (north-west) corner of the transportation table. The maximum feasible amount is allocated there i.e. x = minimum of (a_1, b_1) so that either capacity of

he requirement of the destination D_i is satisfied or
tered in the upper left hand corner i.e. cell (1, 1) in the transportation table.

Step 2: If $b_1 > 0_1$, the capacity of the source is exhausted but requirement at destination (D) is not still satisfied so that at least one more cell in the first column will have to take on a positive value. Move down vertically to the second row and make the second allocation of magnitude $x_2 = \min (a_2, b_1 - x_{11})$. This either exhausts the capacity of the source (S_2) or satisfies the remaining demand at destination D_1.

If $b_1 \leq a_1$, the requirement at destination D_1 is satisfied but the capacity of the source (S_1) is not completely exhausted. Move to the right horizontally to the second column and make the second allocation of magnitude $x_{21} = \min (a_1 - x_{11}, b_2)$. This either exhausts the capacity of sound (S_1) or satisfies the demand at destination (D_1).

If $b_1 = a_1$, the source capacity of S_1 is completely exhausted as well as the requirements destination D_1 is completely satisfied. There is a tied for second allocation. An arbitrary breaking choice is made. Make the second assignment of magnitude $x_{12} = \min (a_1 - a_1, b_2) = 0$, the cell (1, 2) or $x_{21} = \min (a_2, b_1 = b_1) = 0$ in the cell (2,1).

Step 3: Start from the new north-west corner of the transportation table, satisfying destination requirements and exhausting the source capacities on at a time, move down towards the lower right corner of the transportation table until all the rim conditions are satisfied.

Problem: Determine an initial basic feasible solution to the following transportation problem using north-west corner rule

	D_1	D_2	D_3	D_4	Capacity
S_1	6	4	2	5	14
S_2	8	9	2	7	16
S_3	4	3	6	2	5
Requirement	6	10	15	4	35

tion is made in the cell (1, 1), the magnitude of allocation is min (14, 6) = 6. Then move towards second column to the cell (1, 2) to make second allocation and the magnitude of assignment will be min (14 – 6, 10) = 8. The third allocation is made in the cell (2, 2) the magnitude is (16, 10 – 8) = 2. The fourth allocation is done in the cell (2, 3) and the magnitude is (16 – 2, 15) = 14. The fifth allocation being min (5, 15 – 14(= 1, and it is made in the cell (3, 3). The sixth allocation is made in the cell (3, 4) is given by min (5 – 1, 4) = 4.

Now, all the requirements have been satisfied and hence the initial basic feasible solution is obtained. The allocations are shown in the table below.

	D_1	D_2	D_3	D_4	Supply
S_1	6	8			14
S_2		2	14		16
S_3			1	4	5
Demand	6	10	15	4	

The transportation cost is given by

$Z = x_{11}\ C_{11} + x_{12}.\ C_{12} + x_{22}.\ C_{22} + x_{23}\ C_{23} + X_{33}\ C_{33} + x_{34}\ C_{34}$

$= 6 \times 6 + 8 \times 4 + 2 \times 9 + 14 \times 2 + 1 \times 6 + 4 \times 2 = 128$

4.0 CONCLUSION

North-west corner method is an intuitive lowest-cost method of setting an initial solution to transportation problems; this involves the introduction of important technique which is equally important to provide optimal solution to problems.

s another method which can be adopted in solving Educational Problems. It is highly needed to follow certain steps in other to ensure an effect use of the method. It provides optimal solution to Educational problems.

6.0 TUTOR-MARK ASSIGNMENT

1. State the necessary steps needed in North – West Corner Rule to solve Educational problems.

2. Determine an initial basic feasible solution to the following transportation problem using north-west corner rule

	D_1	D_2	D_3	D_4	Capacity
S_1	10	8	6	9	14
S_2	12	13	6	11	16
S_3	8	7	10	6	5
Requirement	10	14	19	8	35

7.0 REFERENCES / FURTHER READINGS

Ascott, Elizabeth. 2006. Benefit Cost Analysis of Wonderworld Drive Overpass in San Marcos, Texas. Applied Research Project. Texas State University. http://ecommons.txstate.edu/arp/104/

Michael Meyer, Eric J Miller. Urban Transportation Planning, McGraw-Hill, 2nd edition, 2000.

PROBLEM III (Vogel's Approximation method)

1.0 INTRODUCTION

Another way of finding an initial solution to problem is through the Vogel's Approximation method which is as simple as the North-west corner method. It is associated with cost, which is an important concept in Educational Planning.

2.0 OBJECTIVES

At the end of the lesson, students should be able to:

i. explain Vogel's Approximation method.

ii. state the various steps in Vogel's Approximation method.

3.0 MAIN CONTENT

3.1 ANOTHER WAY TO FIND AN INITIAL SOLUTION

In addition to the northwest corner and intuitive lowest-cost methods of setting an initial solution to transportation problems, we introduce one other important technique— *Vogel's Approximation method* (VAM). VAM is not quite as simple as the northwest corner approach, but it facilitates a very good initial solution—as a matter of fact, one that is often the *optimal* solution.

Vogel's Approximation method tackles the problem of finding a good initial solution by taking into account the costs associated with each route alternative. This is something that the northwest corner rule did not do. To apply the VAM, we first compute for each row and column the penalty faced if we should ship over the *second best* route instead of the *least-cost* route.

3.2 VOGEL'S APPROXIMATI ON METHOD TO FIND BFS

Vogel's approximation method yields a very good initial solution which reduces the number of iterations to reach the optimal solution. This method takes into account not only the least cost but also brings the solution nearer to optimality.

Vogel's Approximation method is an improved version of the minimum-cost method that generally produces better starting solutions.

determine a penalty measure by subtracting the n the row (column) from the next smallest unit cost element in the same row (column).

(ii) Identify the row or column with the largest penalty. Break ties arbitrarily. Allocate as much as possible to the variable with the least unit cost in the selected row or column .Adjust the supply and demand and cross out the satisfied row or column. If a row and column are satisfied simultaneously, only one of the two is crossed out, and the remaining row (column) is assigned zero supply (demand).

(iii) (a) If exactly one row or column with zero supply or demand remains uncrossed out, stop.

(b) If one row (column) with positive supply (demand) remains uncrossed out, determine the basic variables in the row (column) by the least-cost method .stop.

(c) If all the uncrossed out rows and columns have (remaining) zero supply and demand, determine the zero basic variables by the least-cost method .stop.).[2]

(d) Otherwise, go to step (i).

4.0 CONCLUSION

Vogel's Approximation is another method used in making decision. The method is structured with various steps for its usage.

5.0 SUMMARY

Vogel's Approximation method is an improved version of the minimum-cost method that generally produces better starting solutions. The six steps involved in determining an initial VAM solution.

6.0 TUTOR-MARK ASSIGNMENT

1. Define Vogel's Approximation (VAM)

2. State the various steps attributed to it solution in chronological order.

THER READINGS

Dwivedi, R. K., Mehta, N. N. and Dubey, O. P., Interactive Decision Making in Prioritized Unbalanced Transportation Problems (February 16, 2009). The Icfai University Journal of Operations Management, Vol. 8, No. 1, pp. 67-76, February 2009. Available at SSRN: http://ssrn.com/abstract=1344168

G oval, S. K. (1984), Improving VAM for unbalance transportation problems, *Journal of Operational Research Society* 35, 1113-1114

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...TION PROBLEM IV

...TRANSPORTATION MODEL

1.0 INTRODUCTION

At times, the situation of this model may not be balanced one, in the sense that one of the variables will be higher than the other. This does not mean that there could not be solution. Rather, it calls for dummy.

2.0 OBJECTIVES

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

i. detect the unbalanced transportation model problem situation.
ii. create a dummy to provide solution to the problem.
iii. interpret the solution effectively

3.0 MAIN CONTENT

3.1

Case 1: Supply less than Demand: If the total capacity of the source is not sufficient to meet the requirement of destinations, one or more destination will not receive the full quantity. To make the problem balanced introducing a dummy source with supply exactly equal to excess of demand over supply.

Case 2: Supply greater than Demand: The requirement of destinations is not sufficient to meet the total capacity of the source; one or more destination will not receive the full quantity. To make the problem balanced introducing a dummy source with demand exactly equal to excess of supply over demand.

3.2 Given: An "unbalanced" transportation problem, where the supply of aggregate is not equal to the demand.

initial basic feasible solution to the following ng north-west corner rule

	1	2	3	4	Supply
A	4	6	8	15	50
B	13	10	11	5	70
C	14	4	10	6	30
D	9	11	13	14	50
Demand	25	35	105	20	

Solution: Total supply = 200

Total demand = 125

Surplus Supply = 200 – 125 = 15

As the supply is more than demand, introduce a dummy destination with 15 units as requirement to make the problem balanced.

	1	2	3	4	5	Supply
A	4	6	8	15	0	50
B	13	10	11	5	0	70
C	14	4	10	6	0	30
D	9	11	13	14	0	50
Demand	25	35	105	20	15	200

Now, this balanced problem can be solved by the give procedure.

4.0 CONCLUSION

An unbalance situation is a realistic one. In an unbalanced situation, the problem can be solved through the use of dummy. Dummy is created to ensure balance situation.

itions behind unbalanced transportation problem: Supply less than Demand and Supply greater than Demand. The pre-solution to such situation is through the use of dummy which must be created by the analyst.

6.0 TUTOR-MARK ASSIGNMENT

1. You are in charge of a large construction project that involves two sites. You currently need 50 tons of aggregate at site 1 and 22 tons of aggregate at site 2. Two suppliers are available, and their limits are listed below. Restrictions on the type of work to be done require that at least 20 tons used at site 1 have to come from supplier B and no more than 10 tons of aggregate from supplier A can be used at site 2. Aggregate delivery costs (₦ /ton) are as follows:

Delivery Costs:	To Site1	To Site 2
From Supplier A	₦ 1/ton	₦ 2/ton
From Supplier B	₦ 1.5/ton	₦1.25/ton

Required:

a) Solve this problem as an "unbalanced" transportation problem where the supply exceeds demand, assuming that Supplier A can deliver up to 31 tons, and Supplier B can deliver up to 43 tons.

b) Solve as an ""unbalanced" transportation problem where the available supply is less than the demand, assuming that Supplier A can deliver a maximum of 27 tons, and Supplier B can deliver a maximum of 43 tons.

THER READINGS

J. and Dubey, O. P., Interactive Decision Making in Prioritized Unbalanced Transportation Problems (February 16, 2009). The Icfai University Journal of Operations Management, Vol. 8, No. 1, pp. 67-76, February 2009. Available at SSRN: http://ssrn.com/abstract=1344168

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Pearman, A. D., Two Errors in Quandt's Model of Transportation and Optimal Network Construction *Journal of the Regional Science Association*, 14, 281-286, 1974.

DELS

1.0 INTRODUCTION

This unit illustrates the planning models according to education. Emphasis is also laid on the generic strategies model.

2.0 OBJECTIVES

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

i. explain the planning models

ii. porters Generic Strategies Model

3.0 MAIN CONTENT

3.1 PLANNING MODELS

Corporate Portfolio App roach

This is an approach used by top level management to determine what discipline to engage in, how to manage and maximize societal needs.

Boston consulting group (BCG) matrix

This gives the frame work for evaluating the relative performance of the business in which diversified organization operates. It also prescribes the preferred distribution of each and other resources among these businesses. Using this model, an organization classifies each of its SBU's (or major products, according to two factors – its market share relative to competitors and the growth rate of industry in which the strategic business unit (SBU) operates.

d simply into high and low categories, a 2 x 2 grid is
ure below

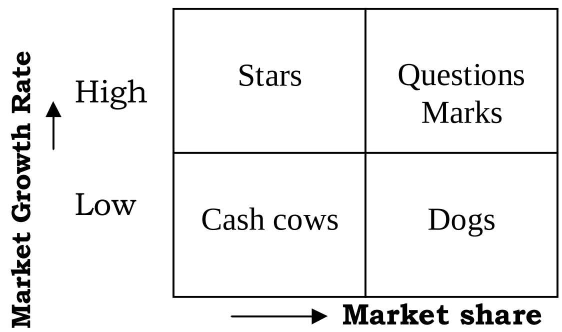


Fig 16a: **Boston Consulting Group Matrix**

The four quadrants in the grid represent distinct categories of SBU's products. The categories differ with respect to not only market share but also market growth rate and also to cash need and appropriate strategies.

- **Stars:**- High market shares and high industry growth rates represent stars. These stars pose a challenge for companies because it requires lots of cash to remain competitive in growing markets. Aggressive marketing strategies are recommended for stars to maintain and even build market share.
- **Cash cows:**- These are the SBUS's that have large share of the market that is not expected to grow substantially. These characteristically generate high profits that the organization should use to support question marks and stars. Cash cows are "milked" for cash to support business in markets that have greater growth potential.
- **Question marks:**- Question makers are called problem children. These are characterized by low market shares but high industry growth rates. A question mark has not achieved a strong foot hold in an expanding but highly competitive market. The BCG matrix suggests that organizations should carefully invest in question marks. I f their performance does not live up to expectations, question marks should be classified as dogs.

business that have a low market share that is not Because these business are not having a good economic promise. The BCG matrix suggests that organizations should not either invest in them or should consider selling them as soon as possible.

An institution should seek a balanced portfolio of SBU's. Certainly, cash cows are indispensable, stars and question marks are integrated to a balanced portfolio, because products in growing markets determine a firm's long term performance. Though dogs are undesirable but company has least one such product. Thus, the portfolios include mix of cows, stars, dogs and question marks.

3.2 Porters Generic Strategies Model

Michael Porter, a Harvard business professor devised a two facto strategy. Scope of target market and differential advantage and then choose and appropriate strategy. Porter's generic strategies model recommends three alternatives for consideration.

- **Overall cost leadership:**- A company of SBU which is large aims at satisfying larger market by producing a standard product at low cost and then underpricing competitors.
- **Differentiation:**- An organization creates a distinctive, unique product through it unsurpassed, innovative design or some other feature and as a result, can charge higher than average price. This strategy may be used to peruse either a broad or narrow target market.
- **Focus:**- A firm concentrates on part of a market and ties to satisfy it with either a very low priced or highly distinctive product. The target ordinarily is set apart by some factor such as geography or specialized needs.

...ability depends upon having a clear distinctive

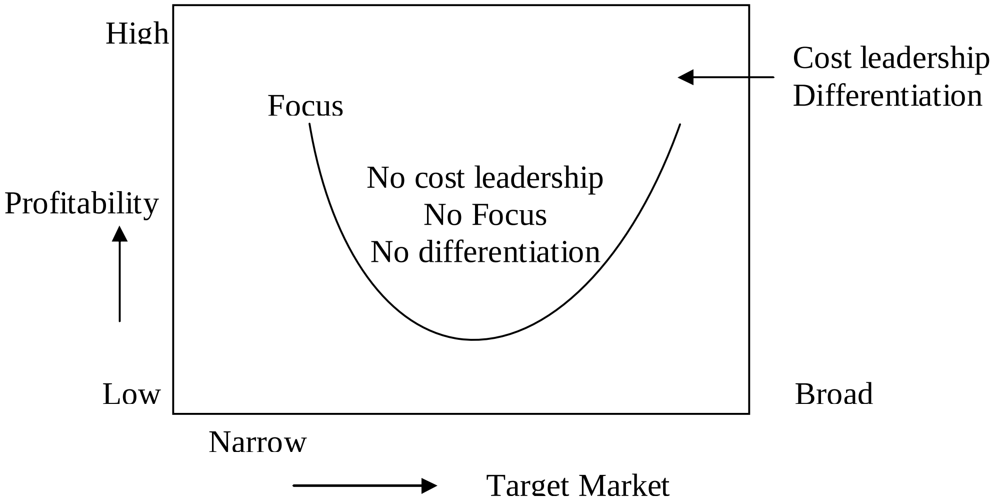


Fig 16b: **Scope of target market portfolio strategy**

4.0 CONCLUSION

The unit was able to illustrate planning models according to educational to educational planning. Generic strategies model was not left out.

5.0 SUMMARY

Corporate Portfolio Approach comprises of **Boston consulting group (BCG) matrix** and **Porters Generic Strategies Model;** overall cost leadership, differentiation and focus as generic strategies model.

6.0 TUTOR-MARK ASSIGNMENT

1. Discuss the various planning models in the establishment and running a school

2. Only planning will not ensure success in the Educational sector. DISCUSS

3. Write on scope of target market portfolio strategy as applicable to Education planning.

THER READINGS

Davis, K. R., P. G. McKeown and T. R. Rakes (1986), *Management Science - An Introduction,* Kent Publishing Company. Boston, MA 02116

OF EDUCATIONAL MODELS

UNIT 1 BREAK-EVEN ANALYSIS

1.0 INTRODUCTION

In decision making, break-even point is essential in other to know whether to stop an action or continue. This unit however deals with the determination of break–even point with diagrammatic illustration; put into consideration the underlining assumptions.

2.0 OBJECTIVES

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

i. explain break-even point analysis

ii. state the assumptions in breakeven analysis

iii illustrate using the appropriate diagram; show break-even analysis

3.0 MAIN CONTENT

3.1 Break even analysis establishes the relationship among the factors affecting the profit. Profits are the functions of prices, costs and volume of activity and the three are related to each other. There are several decisions for which these interrelationships are more important, e.g. the manager is keen to know the breakeven volume – the level at which the firm has just enough revenues to recover all costs. At this level of activity, the firm will not make any money; however, it will not lose money also. It is no profit no loss activity level. This level acts as a reference point for the decision maker who then known, the level of output that must be exceeded if some profit is to be made.

The main objective of CVP analysis is to predict how costs will behave in response to activity level changes. The detailed analysis of break-even data will help the management to understand the effect of alternative decisions that

to fixed, the costs which increase sales volume and
l in evaluating alternative course of action.

3.2 ASSUMPTIONS IN BREAKEVEN ANALYSIS

(1) Selling prices will remain constant at all sales level (Quantity discounts are not allowed).

(2) There is a lingerer relationship between sales volume and costs.

(3) Costs are divided into two categories:

Fixed costs – fixed costs are those costs which do not vary with volume (Quantity) of production.

Variable Costs – are those cost which vary in direct proportion to Quantity

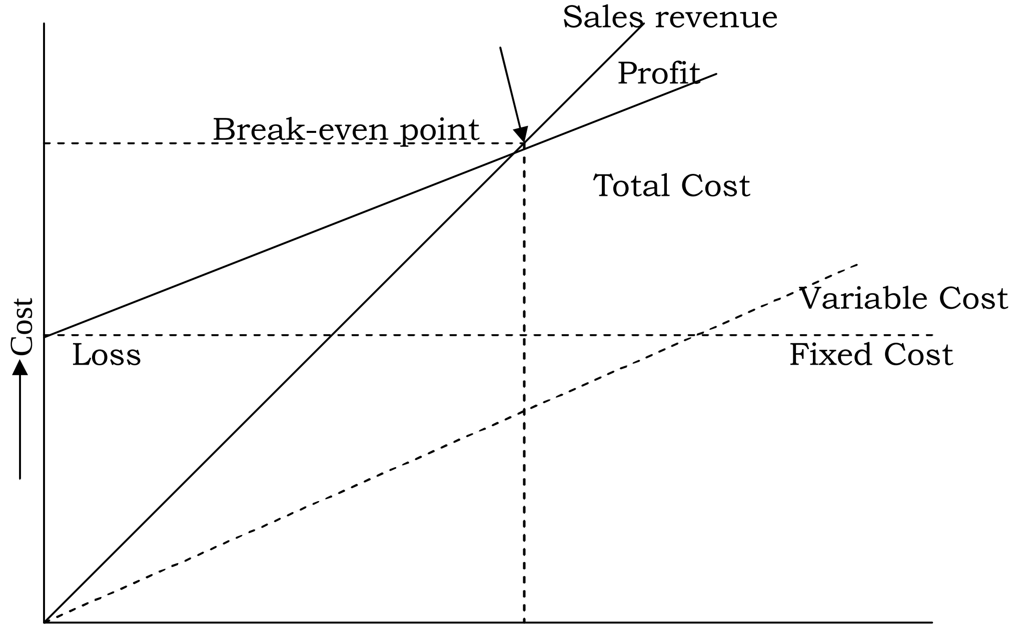
(4) Production and sales quantities are equal (There is no inventory)

(5) No other factors will influence the cost except the quantity.

3.3 BREAKEVEN POINT

Break-even point refers to the level of sales (sales volume) at which the sales income (Revenues) equal the total costs. It is a appoint at which the profit is zero, the quantities produced (sold) above break-even point result in profits and quantity below break-even point result in losses. The break-even point is reached when the fixed costs are completely recovered.

The break-even point is represented as shown below



Quantity →

Fig 17a: **Break-even Chart**

Let F = represents the Fixed Cost

Q = is quantity produced and sold

b = is the sales price per unit

a = is variable cost per unit

bQ = Total income (revenue)

aQ = Total variable cost.

Total cost = Fixed cost + variable cost = F + aQ

At BEP, Total cost equal total income

Therefore, Total cost = Total income.

F + aQ = bQ.

$$Q = \frac{F}{b-a}$$

Contribution = Sales – Variable cost

= b – a

$$\text{Break-even quantity (units)} = \frac{Fixed\ cost}{Contribution}$$

Margin of Safety: Margin of safety is the difference between the existing level of output and the level of output at BEP.

$$\text{Margin of safety} = \frac{Sales - Sales\ at\ BEP}{Sales} x\ 100$$

Angle of Incidence: This is an angle at which the sales line cuts the total cost line. The management aims at large angle of incidence because large angle of incidence indicates a high profit rate. A narrow angle will show that even fixed overheads are absorbed and relatively low rate of return.

3.4 APPLICATINS OF BEP

reak even chart helps the management to know at a at different levels of activity and the safety margin refers to the extent to which an organization can afford to loose its sales before it starts incurring losses.

(2) It helps to plan the profit:- It is useful to calculate the volume needed to attain the target profit. Sometimes the firm aims to generate a particular amount of profit in a specified period. For this purpose, with the help of contribution margin it is convenient to calculate volume of sales necessary to achieve targeted profit.

(3) It helps to compute up to what level the sales price can be reduced in competition or to compute additional sales volume required to maintain a particular level of profit.

(4) It helps to make the decision making with respect to selection of equipment amongst the alternatives, selection of process etc.

(5) It helps to take decision regarding make or buy

(6) It helps to decide the product mix and promotion mix.

4.0 CONCLUSION

The break-even point for a product is the point where total revenue received equals the total costs associated with the sale of the product (TR=TC). A break-even point is typically calculated in order for businesses to determine if it would be profitable to sell a proposed product, as opposed to attempting to modify an existing product instead so it can be made lucrative. Break even analysis can also be used to analyses the potential profitability of an expenditure in a sales-based business. Breakeven point (for output) = fixed cost / contribution per unit. Contribution (p.u) = selling price (p.u) - variable cost (p.u) and breakeven point (for sales) = fixed cost / contribution (p.u) * sp (p.u). *where (p.u) represent per unit.*

There are assumptions in breakeven analysis which must be considered to make decision. Break-even point is determined by Total cost = Total income. This can be applied to safety margin, profit making, computation of performance, decision making, production and promotion mix.

6.0 TUTOR-MARK ASSIGNMENT

1. Agege Grammar school has given the following information on its capacity, enrolment and cost as follows:

a. Current capacity = 100000 units

b. At current level of operations, its margin safety is 50% of its break-even point.

c. Contribution margin P/V Ratio = 25%

d. The unutilized capacity at present is 10000 units

e. Enrolment (relative to School fees) = ₦40

Find: a) Break-even point in enrolment rate.

b) Fixed cost

c) Variable cost per student enrolled

d) Margin safety per student enrolled

2. Represent the above given exercise graphically?

7.0 REFERENCES / FURTHER READINGS

Horngren, C.,Sundem, G & Stratton, W. (2002) "*Introduction to Management Accounting*" Prentice Hall

UNIT 2 LOWRY MODEL

1.0 INTRODUCTION

The model uses economic base theory to determine the total population and employment in service. The population is assigned to zones of the city in proportion to their population potential. Service employment is allocated in proportion to the market potential of each zone. Lowry model aids in the proper assessment of the situations.

2.0 OBJECTIVES

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

i. explain Lowry Model
ii. state the endogenous element of the Lowry model
iii. explain data process structure in Lowry model
iv. state variables and models of Lowry model

3.0 MAIN CONTENT

3.1 Lowry Model

Developed by I. S. Lowry in 1964, this is a model of the evolution and distribution of urban land use residential, industrial, and service and the urban qualities of total population and primary, secondary, and tertiary industry also is the establishment of educational institution. It is based on the assumption that activities can be predicted from a given level of basic employment. The model uses economic base theory to determine the total population and employment in service industries. The population is assigned to zones of the city in proportion to their population potential. Service

. proportion to the market potential of each zone. eet land use constraints, notably housing densities, and threshold populations for the various services. The model is run several times while allocations are determined until the system reaches equilibrium.

The Lowry model was one of the first transportation / land use model to be developed in 1964 for the Pittsburgh region. Even if its formulation is rather simple, it depicts well the relationships between transportation and land use. Its premises were expended by several other models, known as "Lowry-type" models. The core assumption of the Lowry model assumes that regional and urban growth (or decline) is a function of the expansion (or contraction) of the basic sector. This employment is in turn having impacts on the employment of two other sectors, retail and residential. It produces goods and services, which are exported outside the urban area. It generates a centripetal flow of capital into the city generating growth and surpluses. Most industrial sector employment is within this category. It is generally assumed that this sector is less constrained by urban location problems since the local market is not the main concern. This consideration is an exogenous element of the Lowry model and must be given.

Retail sector (non-basic sector). This employment meets the local demand. It does not export any finished goods and services and use the region as its main market area. It accounts mostly for services such as retailing, food and construction. Since this sector strictly serves the local / regional demand, location is an important concern. Employment levels are also assumed to be linked with the local population. This consideration is an endogenous element of the Lowry model.

Residential sector. The number of residents is related to to the number of basic and retail jobs available. The choice of a residential area is also closely

. This consideration is an **endogenous element** of

Employment in the basic sector influences the spatial distribution of the population and of service employment. This level of influence is related to **transport costs**, or the friction of distance. The higher the friction of distance, the closer places of employment (basic and non-basic) and residential areas are. Overall, the Lowry model has three assumptions:

- The residential sector, and thus urban land use, is a **function of employment**. This function is calculated assuming multiplier effects of basic and non-basic employment. Each job is thus linked to a number of people.
- The total employment is a function of the employment in the basic sector. The retail employment is thus the result of a **multiplier effects on the basic sector** .
- The location of the population is a function of the costs involved to go to their place of work, a **gravity-based friction of distance function** .

3.2 Data Process Structure

The model aims to establish a representation of the residential structure, of employment and of services in an urban area. With an **exogenous spatial distribution of the basic sector employment** and a set of transport costs between zones, the model calculates total population and employment by zone. It is composed of an economic sub-model and a spatial allocation sub-model, which are subject to constraints.

- The first sub-model establishes the **impacts of the basic employment** over the non-basic employment and over the population.

…l establishes the **distribution of the population** in …y and transport costs. This is done by a gravity-type **spatial interaction model** .

The two sub-models require a set of basic data and resolve the problem as follows:

1. The spatial distribution of basic employment is assumed as given.
2. The location of the basic workers is determined according to a location-probability matrix, itself the result of a least friction of distance function.
3. Calculation of the residential sector per zone according to the population per worker multiplier.
4. Calculation of the number of non-basic workers per zone to service the population. This is the result of a non-basic worker per capita multiplier.
5. The location of non-basic workers is determined according to a location-probability matrix.
6. Revision of the total population according to the population per worker multiplier.
7. Calculation of the total number of workers and the total population. This is the summation of the basic and non-basic employment and of the basic and non-basic related population.
8. The above processes (4 to 7) are repeated until a convergence is reached, that is an optimization of the equation system of the model following a set of constrains such as density.

3.3 Variables and Model

The model can be singly constrained, that is the only constraint is the fixed location of basic employment, as it is the case for the below set of equations. It

...ined, where the location of basic employment and ...gly constrained Lowry model is solved according to these equations:

$$T_{ij} = \frac{E_j \bullet LPR_{ij} \exp(-Lambda \bullet d_{ij})}{\sum_i LPR_{ij} \exp(-Lambda \bullet d_{ij})}$$

$$S_{ij} = \frac{(beta \bullet P_i) \bullet TPS_{ij} \exp(-Lambda \bullet d_{ij})}{\sum_i TPS_{ij} \exp(-Lambda \bullet d_{ij})}$$

$$P_i = Alpha \sum_j T_{ij}$$

$$LPR_{ij} = \frac{WTTR_{ij}}{\sum_j WTTR_{ij}} \quad LPS_{ij} = \frac{WTTS_{ij}}{\sum_j WTTS_{ij}}$$

$$WTTR_{ij} = \frac{1}{d_{ij}^{lambda}} \quad WTTS_{ij} = \frac{1}{d_{ij}^{Micron}}$$

$$ES_{ij} = \sum_i S_{ij}$$

$$E_j = EB_j + ES_j$$

$$\sum_i T_{ij} = E_j$$

$$\sum_j S_{ij} = Beta \bullet P_i$$

- Tij = Interaction from residential zone i to work zone j (work-related travel).
- Sij = Interaction from residential zone i to service zone j (service-related travel).
- Pi = Total population of a zone i.
- Ei, EBi and ESi = Total employment, employment in the basic (B) and service (S) sectors for zone i.
- dij = Euclidean distance between zone i and j (in km).

- ...ver basic employment multiplier.
- ...ment over population multiplier.
- Lambda: Friction factor for residential interactions.
- Micron: Friction factor for services interactions.
- WTTRij and WTTSij = Willingness to travel for Residential (R) or Services (S) between zone i and j.
- LPRij and LPSij = Locational probability for Residential (R) or Services (S) between zone i and j.

The Lowry model has obviously several limitations. It is notably a static model, which does not tell anything about the evolution of the transportation / land use system. Furthermore, current economic changes are in the service (non-basic) sectors, forming the foundation of urban productivity and dynamics in many metropolitan areas. Under such circumstances the model is likely to be inaccurate in the major service-oriented metropolitan areas of today. A way to overcome this issue is to consider some non-basic service employment as basic. The Lowry model does not consider movements of freight in urban areas, which are very significant and have impacts on the friction of distance.

3.4 Lowry Model

Flow chart gives the logic of the Lowry model. It is demand driven. First, the model responds to an increase in basic employment. It then responds to the consequent impacts on service activities. As Lowry treated his model and as the flow chart indicates, the model is solved by iteration. But the structure of the model is such that iteration is not necessary.

Although the language giving justification for the model specification is an economic language and Lowry is an economist, the model is not an economic model. Prices, markets, and the like do not enter.

ion will suggest reasons why his approach has been ation was the first full elaboration of a model, data analysis and handling problems, and computations. Lowry's writing is excellent. He is candid and discusses his reasoning in a clear fashion. One can imagine an analyst elsewhere reading Lowry and thinking, "Yes, I can do that."

The diffusion of innovations of the model is interesting. Lowry was not involved in consulting, and his word of mouth contacts with transportation professionals were quite limited. His interest was and is in housing economics. Lowry did little or no "selling." We learn that people will pay attention to good writing and an idea whose time has come.

The model makes extensive use of gravity or interaction decaying with distance functions. Use of "gravity model" ideas was common at the time Lowry developed his model; indeed, the idea of the gravity model was at least 100 years old at the time. It was under much refinement at the time of Lowry's work; persons such as Alan Voorhees, Mort Schneider, John Hamburg, Roger Creighon, and Walter Hansen made important contributions. The Lowry Model provided a point of departure for work in a number of places. Goldner (1971) traces its impact and modifications made. Steven Putnam at the University of Pennsylvania used it to develop PLUM (Projective Land Use Model) and I(incremental)PLUM. We estimate that Lowry derivatives are used in most MPO studies, but most of today's workers do not recognize the Lowry heritage, the derivatives are one or two steps away from the mother logic.

4.0 CONCLUSION

We have been able to discuss in detail Lowry Model, the endogenous element of the Lowry model, the data process structure and the variables of Lowry model as a fundamental concept to educational planning technique.

5.0 SUMMARY

about the evolution and distribution of urban land industries and other institutions and othe productive sectors.

* The singly constrained Lowry model is

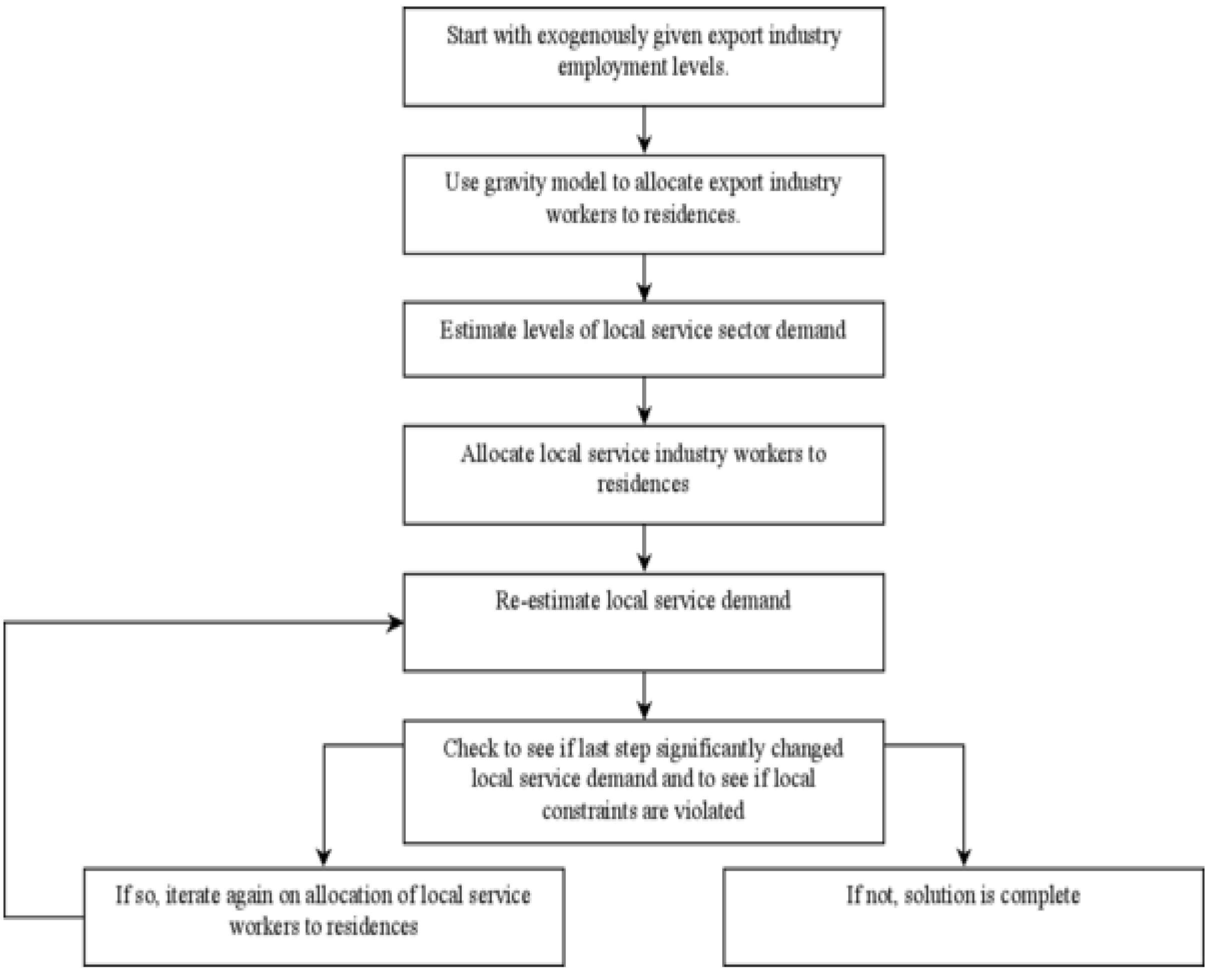


Fig 18a: ***The structure of the Lowry model is shown on the flow chart above.***

6.0 TUTOR-MARK ASSIGNMENT

1. Explain Lowry Model and state the endogenous element of the Lowry model.

ucture in Lowry model and the variables associated

3. Relate the Lowry model and associated variables to educational planning process.

7.0 REFERENCES / FURTHER READINGS

Irwin, Richard D. (1965) "Review of Existing Land-Use Forecasting Techniques," *H*ighway *Research Record* No. 88, pp. 194-199.

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UNIT 3 FORECASTING TECHNIQUES

1.0 INTRODUCTION

Forecasting plays a crucial role in the development of plans for the future. It is essential for the organization to know for what level of activities one is planning before investments in inputs i.e. men, machines and materials are made.

2.0 OBJECTIVES

At the end of this unit, students should be to:

i. explain the concept of "forecasting techniques"
ii. state the relationship between forecasting and Prediction
iii. state the needs for forecasting
iv. long term and short term forecasts
v. classify forecasting according to methods

3.0 MAIN CONTENT

3.1 CONCEPT OF FORECASTING TECHNIQUES

Before making an investment decision, many questions will arise,

What should be the size or amount of capital required? How large should be the size of the work force? What should be the size of the order and safety stock? What should be the capacity of the plant?

The answers to the above questions depend upon the forecast for the future level of operations. Modern production activities are becoming more complex technologically and the basic inputs are becoming expensive and there are lots

The planning of production activity is therefore ources are put to their best use. Planning is a fundamental activity of management. Forecasting forms the basis of planning and enables the Organization to respond more quickly and accurately to market changes. Forecasting as defined by American Marketing Association is:

"An estimate of sales in physical units (or monetary value) for a specified future period under proposed marketing plan or programme and under the assumed set of economic and other forces outside the Organization for which the forecast is made", Forecasting is thus looked upon as a projection based on the past data. Forecasting is not a guess work. It is the inference based on large volume of data on past performance.

Forecasting is an important component of strategic and operational planning. It establishes a link between planning and controlling. It is essential for planning; scheduling and controlling the system to facilitate effective and efficient output of goods and services.

3.2 FORECASTING AND PREDICTION

Prediction is an estimate of future event through subjective considerations other than just the past data. For prediction, good subjective estimation is based on managers' skill experience and judgement. There is an influence of one's own perception and bias in prediction. So it is less accurate and has low reliability. Forecasting is an estimate of future event achieved by systematically combining and casting foreword in a predetermined way data about the past.

Forecasting is based on the historical data and it requires statistical and management science techniques. When we refer to forecasting, usually it is some combination of forecasting and prediction.

3.3 NEED FOR DEMAND FORECASTING

(1) Majority of the activities of the industries depend upon the future sales.

for the future assists in decision making with
ent in plant and machinery, market planning and programmes.

(3) To schedule the production activity to ensure optimum utilization of plant's capacity.

(4) To prepare material planning to take up replenishment action to make the materials available at right quantity and right time.

(5) To provide information about the relationship between demands for different products in order to obtain a balanced production in terms of quantity required of different products as a function of time.

(6) Forecasting is going to provide a future trend which is very much essential for product design and development.

Thus, in this changing and uncertain techno-economic and marketing scenario, forecasting helps to predict the future with accuracy.

3.4 LONG TERM AND SHORT TERM FORECASTS

Depending upon the period for which the forecast is made, it is classified as long term forecasting and short term forecasting. Forecasts which cover the periods less than one year are termed as short term forecasting. Forecasts which cover the period over one year (5 years or 10 years) future are termed as long term forecasts.

Short term forecasts are made for purpose of materials control, loading, scheduling and budgeting.

Long term forecasts are made for the purposes of Production diversification, sales and advertising budgets, capacity planning and investment planning.

3.5 CLASSIFICATION OF FORECASTING METHODS

A large number of forecasting techniques with various degrees of complexity are available to the forecaster these days. The availability of computer programemems have facilitate the task of the forecaster. The methods

…ive depending upon the individual judgements and …zing the quantitative information.

In general, forecasting methods are classified as:

(1) Time Series methods.

(2) Judgmental techniques.

(3) Causal methods (Econometric Forecasting)

The judgemental technique is a method which relies on the art of human judgment. This is in practice since long time. The other two techniques are relatively new and heavily use statistics for analyzing the past data.

In econometric forecasting the analyst tries to establish cause and effect relationships between sales and some other parameter that are related to sales, i.e. the demand for cement depends upon the projected growth to construction industry.

The objective in this method is to establish a cause and effect relationship between changes in the sales of the product and et of relevant explanatory variable. It utilizes regression and correlation analysis.

Time series analysis, identifies the historical pattern of demand for the product and project or extrapolate this demand in the future. The important of making inference about future on the basis of what has happened in the past is called time series analysis.

4.0 CONCLUSION

This unit has been able to define "forecasting techniques" as the basis to planning in other to make right decision. The relationship between forecasting and Prediction, importance of forecasting and the type of long and short term forecasting could be adopted to ensure effective planning in education.

5.0 SUMMARY

*Forecasting forms the basis of planning and enables the Organization to respond more quickly and accurately to market changes.

of future event through subjective considerations ata. For prediction, good subjective estimation is based on managers' skill experience and judgement.

* Forecasting methods are classified as: Time Series methods, Judgmental techniques and Causal methods (Econometric Forecasting)

6.0 TUTOR-MARK ASSIGNMENT

1. Using a case study of a public secondary school in your locality, forecast and predict the enrolment rate, retention rate and flow rate of students based on the available data from a reliable source.

2. Diagnose the Educational sector of a State in your country, highlight and discuss the long and short term forecasts schedule in planning for the sector.

7.0 REFERENCES / FURTHER READINGS

Irwin, Richard D. "Review of Existing Land-Use Forecasting Techniques," *Highway Research Record* No. 88, pp. 194-199. 1965.

Robinson Ira M. (ed.) *Decision Making in Urban Planning,* Sage Publications, 1972.

UNIT 4 OPTIMIZATION MODELS

1.0 INTRODUCTION

In this unit we will discuss both static and dynamic models. We begin with techniques for finding optimum solutions to static models, and then discuss how to extend these to handle dynamic models. We shall discuss the basic approach known as dynamic programming at an elementary level for solving problems that are posed as multi-period or multistage deems.

2.0 OBJECTIVES

At the end of this chapter, students should be to:

i. define Optimization models
ii. differentiate between single versus multiobjective models
iii. differentiate between static versus dynamic models
iv. differentiate between stochastic and deterministic models
v. various types of optimization models

3.0 MAIN CONTENT

3.1 Optimization Models

The model of restrictions and constraints for the decision problem is a single linear equation in one decision variable which has a unique solution. This is quite rare. Such models for most real world decision problems have many solutions. The question that arises then is how to select one of the many plement?. This is usually done so as to optimize an a measure of effectiveness of the relevent system.

Since prehistoric times, humans have had an abiding interest in optimizing the performance of systems that they use. Now-a-days all the decisions that we make at work, and those affecting our personal lives, usually have the goal of optimizing some desirable characteristic. If there are some objective functions to optimize in addition to satisfying the requirements on the decision variables, the resulting model is known as an optimization model.

Each of the objectives to optimize is typically a measure of effectiveness of performance of the relevant system, and should be expressed as a mathematical function of the decision variables.

If higher values of a measure of performance are more desirable (such a measure could be considered as a profit measure) we seek to attain the maximum or highest possible value for it. If lower values of a measure of performance are more desirable (such a measure could be interpreted as a cost measure) we seek to attain the minimum or the lowest possible value for it. The various measures of performance are usually called the objective function(s) in the mathematical model for the system. To optimize an objective function means to either maximize or minimize it as desired.

If there is only one measure of performance (such as yearly total profit, or production cost per unit, etc.) the model will be a single objective model. When there are several measures of performance, we get a multiobjective model in which two or more objective functions are required to be optimized simultaneously.

In optimization models the requirements come from the relationships that must hold among the decision variables and the various static or dynamic structural elements by the nature of system operation.

Each requirement leads to a constraint on the decision variables that will be expressed as a mathematical equation or inequality in the model for the problem. The model also includes any bounds (lower and/or upper) that the functions of them must satisfy in order to account under which the system must operate.

In some problems, in addition to all these requirements, there may be others that specify that the values of some decision variables must come from specified sets (for example, if the decision variable x_1 is the diameter of pipe used in designing a component, and this pipe is available in diameters 1”, or 1.5”, or 2” only; then the value of x_1 must come from the set {1□□, 1.5□□, 2□□}).

We know that if an objective function is a cost function (profit function) we would like to minimize (maximize) it. Fortunately, it is not necessary to consider minimization and maximization problems separately, since any minimization problem can be transformed directly into a maximization problem and vice versa. For example, to maximize a function f(x) of decision variables x, is equivalent to minimizing −f(x) subject to the same system of constraints, and both these problems have the same set of optimum solutions. Also, we can use □ Maximum value of f(x) subject to some constraints □ = −□□□ Minimum value of −f(x) subject to the same constraints□□□

For this reason, we will discuss algorithms for minimization only in this book.

Let $x = (x_1, . . . ,x_n)^T$ denote the vector of decision variables. A typical single objective optimization model has the following form:

Minimize θ(x) (1.3.1)

subject to $g_i(x)$ □ = b_i, i= 1, . . . ,m

≤ b_i, i= m+ 1, . . . ,m+ p(1.3.2)

□$_j$ ≤ x_j ≤ u_j, j= 1, . . . ,n (1.3.3)

x_j □ Δ_j, j□ J □ {1, . . . , n}. (1.3.4)

where all the functions are assumed to be continuous and differentiable, and for each j □ J, Δ_j is a specified set within which the value selected for the variable x_j is required to lie. The function $g_i(x)$, constant b_i are respectively the constraint function, RHS constant respectively for the ith constraint in (1.3.2).

Any “≥” inequality constraint can be transformed into a “≤” constraint by multiplying both sides of it by −1. That’s why we listed all the inequality constraints in the “≤” form.

ower bounds on the decision variable x_j. In many mmon (i.e., x_j is required to be nonnegative) because economic activities can only be carried out at nonnegative levels. But in general $\square_j$, u_j can have any real values satisfying $\square_j \leq u_j$, in fact we can have $\square_j = -\infty$ and $u_j = +\infty$ (in this case x_j is called an unrestricted variable.

Constraints like those in (1.3.4) mainly arise in discrete problems where some variables are required to assume only values from specified discrete sets.

For (1.3.1)−(1.3.4), a numerical vector x is said to be a feasible solution if it satisfies all the constraints (1.3.2)−(1.3.4). A feasible solution $\bar{x}$ satisfying $\theta(\bar{x}) \leq \theta(x)$ for all feasible solutions x is said to be an optimum solution or optimum feasible solution for (1.3.1) to (1.3.4), because it has the smallest value for the objective function among all feasible solutions.

The typical multiobjective problem is of the form Minimize $\theta_i(x)$; i = 1 to k simultaneously subject to constraints of form (1.3.2)−(1.3.4).

If constraint (1.3.4) is absent, the above models are said to be continuous variable optimization models since each variable can assume any value within its bounds subject to the other constraints. If constraints (1.3.4) are there, and Δ_j are discrete sets (like the set of integers, or the set {0, 1} etc.) the models are said to be discrete optimization models.

3.2 SINGLE VERSUS MULTIOBJECTIVE MODELS

Mathematical theory of single objective models is well developed. In contrast, for multiobjective optimization models, we do not even have the concept of an optimum solution. Often, the various objective functions conflict with each other (i.e., optimizing one of them usually tends to move another towards undesirable values), for solving such models one needs to know how many units of one function can be sacrificed to gain one unit of another, but this trade-off information is not available. In other words, one is forced to determine the best compromise that can be achieved. Since trade-off information among the various objective functions is not given, multi-objective optimization y stated mathematical problems. Techniques for ivolve trial and error using several degrees of compromises among the various objective functions until a consensus is reached that the present solution looks reasonable from the point of view of all the objective functions.

We restrict the scope of this unit to single objective optimization models.

3.3 STATIC VERSUS DYNAMIC MODELS

Models that deal with a one-shot situation are known as static models. These include models which involve determining an optimum solution for a one period problem. For example, consider the production planning problem in a company making a variety of products. To determine the optimum quantities of each product that this company should produce in a single year, leads to a static model.

However, planning does involve the time element, and if an application is concerned with a situation that lasts over several years, the same types of decisions may have to be made in each year. In the production planning problem discussed above, if a planning horizon of 5 years is being considered, it is necessary to determine the optimum quantities of each product to produce, in each year of the planning horizon. Models that involve a sequence of such decisions over multiple periods are called multi-period or dynamic models.

When planning for a multi-period horizon, if there is no change in the data at all from one period to the next, then the optimum solution for the first period determined from a static model for that period, will continue to be optimal for every period of the planning horizon. Thus multi-period problems in which the changes in the data over the various periods are small, can be handled through a static one period model, by repeating the same optimum solution in every period. Even when changes in the data from one period to the next are significant, many companies find it convenient to construct a static single period model for their production planning decisions, which they solve at the with the most current estimates of data for the ...od. This points out the importance of static models, even though most real world problems are dynamic. In most multi-period problems, data changes from one period to the next are not insignificant. In this case the optimum decisions for the various periods may be different, and the sequence of decisions will be interrelated, i.e., a decision taken during a period may influence the state of the system for several periods in the future. Optimizing such a system through a sequence of single period static models solved one at a time, may not produce a policy that is optimal over the planning horizon as a whole. However, constructing a dynamic model with the aim of finding a sequence of decisions (one for each period) that is optimum for the planning horizon as a whole, requires reasonably accurate estimates of data for each period of the planning horizon. When such data is available, a dynamic model tries to find the entire sequence of interrelated decisions that is optimal for the system over the planning horizon.

3.4 STOCHASTIC VERSUS DETERMINISTIC MODELS

An optimization model in which there is no uncertainty (i.e., all the data elements are known with certainty) is known as a deterministic optimization model.

In a single objective static optimization model, the objective function can be interpreted as the yield or profit that is required to be maximized. The objective function expresses the yield as a function of the various decision variables. In real world applications, the yield is almost never known with certainty, typically it is a random variable subject to many random fluctuations that are not under our control.

For example the yield may depend on the unit profit coefficients of the various goods manufactured by the company (these are the data elements in the model) and these things fluctuate randomly. To analyze the problem treating the yield as a random variable requires the use of complicated stochastic optimization (programming) models.

lyses the problem using a deterministic model in s in the yield function are replaced by either their most likely values, or expected values etc. The solution of the deterministic approximation often gives the decision maker an excellent insight for making the best choice. We can also perform sensitivity analysis on the deterministic model. This involves a study of how the optimum solution varies as the data elements in the model vary within a small neighborhood of their current values. Decision makers combine all this information with their human judgment to come up with the best decision to implement.

Some people may feel that even though it is more complicated, a stochastic programming model treating the data elements as random variables (which they are), leads to more accurate solutions than a deterministic approximation obtained by substituting expected values and the like for the data elements. In most cases this is not true. To analyze the stochastic model one needs the probability distributions of the random data elements. Usually, this information is not available.

One constructs stochastic models by making assumptions about the nature of probability distributions of random data elements, or estimating these distributions from past data. The closeness of the optimum solution obtained from the model may depend on how close the selected probability distributions are to the true ones. In the world of today, economic conditions and technology are changing constantly, and probability distributions estimated in a month may no longer be valid in the next. Because of this constant change, many companies find it necessary almost in every period to find a new optimum solution by solving the model with new estimates for the data elements. In this mode, an optimum solution is in use only for a short time (one period), and the solution obtained by solving a reasonable deterministic approximation of the real problem is quite suitable for this purpose. For all these reasons most real world optimization applications are based on deterministic models. In this book we discuss only methods for solving deterministic optimization models.

IN PRACTICE

with decision making. Optimization techniques provide tools for making optimal or best decisions. To maintain their market position, or even to continue to exist in business these days, businesses everywhere have to organize their operations to deliver products on time and at the least possible cost, offer services that consistently satisfy customers at the smallest possible price, and introduce new and efficient products and services that are cheaper and faster than competitors. These developments indicate the profound importance of optimization techniques. The organizations that master these techniques are emerging as the new leaders. All the countries in the world today that have a thriving export trade in manufactured goods have achieved it by applying optimization techniques in their manufacturing industries much more vigorously than the other countries.

3.6 VARIOUS TYPES OF OPTIMIZATION MODELS

When constraints (1.3.4) are not there, the optimization model (1.3.1) − (1.3.3) is said to be a linear programming model (LP) if all the functions $\theta(x)$, $g_i(x)$ are linear functions (i.e., each of them is of the form $a_1x_1 + . . . + a_nx_n$, where $a_1, . . . ,a_n$ are given constants). LP is a very important model because it has many applications in a wide variety of areas. Also, many other models are solved by algorithms that have subroutines which require the solution of LP sub problems.

The rich mathematical theory of LP is in a very highly developed and beautiful state, and many efficient algorithms have been developed for solving LPs. High quality software implementations of these algorithms are also widely available. Chapters 3 to 6 discuss examples of LP applications, and algorithms for solving and analyzing LP models including specialized LP models with special properties.

The optimization model (1.3.1)−(1.3.4) is said to be a linear integer programming model (ILP) or commonly IP if all the functions $\theta(x)$, $g_i(x)$ are linear functions, and all the sets Δ_j are the set of integers. Often the word model is referred to as an integer program or IP. IP able than LP since combinatorial choices found in many applications and combinatorial optimization problems can be modeled using binary and integer variables. IP theory is well developed, but more so in a negative way.

For many IP models existing algorithms can only handle problems of moderate size within a reasonable time. So, the development of clever and ingenious heuristic approaches to obtain reasonable solutions to large IP models fast is a highly thriving area of research.

4.0 CONCLUSION

We have discussed classifications of decision problems into several types:

The Categories are; Deterministic, stochastic; Single period, multiperiod; Static, dynamic; Single objective, multiobjective. Mathematical models for some multiperiod decision problems can be expressed in a form similar to (1.3.1)−(1.3.4), but also discusses the recursive approach that can be applied on simple problems posed in the multiperiod format directly without using such models. The application of this recursive approach to solve simple project planning problems without any complicating constraints is the subject.

Finally, when constraints (1.3.4) are not there, and at least one of the functions $\theta(x)$, $g_i(x)$ is nonlinear, (1.3.1)−(1.3.3) is known as a continuous variable nonlinear program (NLP). Development of the theory of nonlinear programming has been going on ever since Newton and Lebnitz discovered calculus in the 17th century. We do not discuss NLP models in this book. The subject that includes linear, integer, and nonlinear programming problems under its umbrella is called mathematical programming.

5.0SUMMARY

*Optimization model is an objective functions to optimize in addition to satisfying the requirements on the decision variables.

* Optimization is concerned with decision making. Optimization techniques provide tools for making optimal or best decisions.

ASSIGNMENT

Explain these classifications clearly. Think of some examples of your own for each type and explain them in complete detail.

1 Discuss some strategies used in practice for handling stochastic decision problems, explaining why they may be preferred to others.

2 Explain the practical difficulties in applying the many nice approaches developed in theory to handle multiperiod decision problems, on problems involving many periods.

3 Think of some decision problems involving optimization, and state them clearly in your own words. Explain what data you will need to solve them. Discuss how you will handle these problems using your present state of knowledge without looking at the rest of this book. Keep these with you. Later after you have studied the book allover again completely, review these notes and see if studying this book has helped you reach better decisions for these problems.

7.0 REFERENCES / FURTHER READINGS

K. G. MURTY, Sophomore Level Self-Teaching Webbook for Computational and Algorithmic Linear Algebra and n-Dimensional Geometry,available at the website:http://ioe.engin.umich.edu/people/fac/books/murty/ algorithmic linear algebra/

UNIT 5 DECISION THEORY MODEL

1.0 INTRODUCTION

Anyone who holds a technical, managerial, or administrative job these days is faced with making decisions daily at work. This chapter examines decision theory models as applicable to the educational planning.

2.0 OBJECTIVES

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

i. define decision theory
ii. explain normative and descriptive theory
iii. discuss the various kinds of decisions need of a theory
iv. categories of decision making problem

3.0 MAIN CONTENT

3.1 Normative and descrip tive decisio n theory

Most of decision theory is normative or prescriptive, i.e., it is concerned with identifying the best decision to take, assuming an ideal decision maker who is fully informed, able to compute with perfect accuracy, and fully rational. The practical application of this prescriptive approach (how people actually make decisions) is called decision analysis, and aimed at finding tools, methodologies and software to help people make better decisions. The most systematic and comprehensive software tools developed in this way are called decision support systems. Since it is obvious that people do not typically behave in optimal ways, there is also a related area of study, which is a positive or descriptive describe what people will actually do. Since the often creates hypotheses for testing against actual behaviour, the two fields are closely linked. Furthermore it is possible to relax the assumptions of perfect information, rationality and so forth in various ways, and produce a series of different prescriptions or predictions about behaviour, allowing for further tests of the kind of decision-making that occurs in practice.

3.2 What kinds of decisions need a theory?

Choice under uncertainty: This area represents the heart of decision theory. The procedure now referred to as expected value was known from the 17th century. Blaise Pascal invoked it in his famous wager, which is contained in his Pensées, published in 1670. The idea of expected value is that, when faced with a number of actions, each of which could give rise to more than one possible outcome with different probabilities, the rational procedure is to identify all possible outcomes, determine their values (positive or negative) and the probabilities that will result from each course of action, and multiply the two to give an expected value. The action to be chosen should be the one that gives rise to the highest total expected value. In 1738, Daniel Bernoulli published an influential paper entitled Exposition of a New Theory on the Measurement of Risk, in which he uses the St. Petersburg paradox to show that expected value theory must be normatively wrong. He also gives an example in which a Dutch merchant is trying to decide whether to insure a cargo being sent from Amsterdam to St Petersburg in winter, when it is known that there is a 5% chance that the ship and cargo will be lost. In his solution, he defines a utility function and computes expected utility rather than expected financial value.

Competing decision makers: Some decisions are difficult because of the need to take into account how other people in the situation will respond to the decision that is taken. The analysis of such social decisions is more often treated under the label of game theory, rather than decision theory, though it

…tical methods. From the standpoint of game theory …ed in decision theory are one-player games (or the one player is viewed as playing against an impersonal background situation). In the emerging socio-cognitive engineering the research is especially focused on the different types of distributed decision-making in human organizations, in normal and abnormal/emergency/crisis situations.

Complex decisions: Other areas of decision theory are concerned with decisions that are difficult simply because of their complexity, or the complexity of the organization that has to make them. In such cases the issue is not the deviation between real and optimal behaviour, but the difficulty of determining the optimal behaviour in the first place. The Club of Rome, for example, developed a model of economic growth and resource usage that helps politicians make real-life decisions in complex situations.

Paradox of choice: Observed in many cases is the paradox that more choices may lead to a poorer decision or a failure to make a decision at all. It is sometimes theorized to be caused by analysis paralysis, real or perceived, or perhaps from rational ignorance. A number of researchers including Sheena S. Iyengar and Mark R. Lepper have published studies on this phenomenon.[2] This analysis was popularized by Barry Schwartz in his 2004 book, The Paradox of Choice.

Statistical decision theory: Several statistical tools and methods are available to organize evidence, evaluate risks, and aid in decision making. The risks of Type I and type II errors can be quantified (estimated probability, cost, expected value, etc) and rational decision making is improved.

One example shows a structure for deciding guilt in a criminal trial:

		Actual condition	
		Guilty	Not guilty
Decision	Verdict of 'guilty'	True Positive	False Positive (i.e. guilt reported unfairly) Type I error
	Verdict of 'not guilty'	False Negative (i.e. guilt not detected) Type II error	True Negative

Alternatives to probability theory: A highly controversial issue is whether one can replace the use of probability in decision theory by other alternatives. The proponents of fuzzy logic, possibility theory, Dempster-Shafer theory and info-gap decision theory maintain that probability is only one of many alternatives and point to many examples where non-standard alternatives have been implemented with apparent success; notably, probabilistic decision theory is sensitive to assumptions about the probabilities of various events, while non-probabilistic rules such as minimax are robust, in that they do not make such assumptions.

3.3 Decision Making: A situation such as educational planning requires some decisions to be made is known as a decision making problem or just decision problem. These problems arise in the operation of some system known the problem. The person(s) responsible for making ...e decision maker(s) for the problem.

At one extreme, these decision making problems may be quite simple requiring the determination of the values of a small number of controllable variables with only simple conditions to be met; and at the other extreme they may be large scale and quite complex with thousands of variables and many conditions to be met. Decision making always involves making a choice between various possible alternatives. Decision problems can be classified into two categories with very distinct features. It is important to understand the difference between these categories.

It may involve:

- determining which ingredients and in what quantities to add to a mixture being made so that it will meet specifications on its composition,
- selecting one among a small number of suppliers to order raw materials from,
- determining the quantities of various products to manufacture in the next period,
- allocating available funds among various competing agencies,
- determining how to invest savings among available investment options,
- deciding which route to take to go to a new location in the city,
- allocating available farm land to various crops that can be grown,
- determining how many checkout lanes to staff during a period of stable demand in a grocery store, etc.

Two Categories of Decision Making Problems

Category 1: This category includes all decision problems for which the set of possible alternatives for the decision is a finite discrete set typically consisting of a small number of elements, in which each alternative is fully known in complete detail, and any one of them can be selected as the decision. Even though many textbooks do not discuss these problems, these are the most common decision problems encountered in daily living,

in school, at work, and almost everywhere. Some examples of this category are:

boys all of whom she likes, and has to decide who
th.

• An automobile manufacturer has to decide whether to use a cast iron engine block, or an aluminum engine block in their new car line.

• A company has received merger offers from three other companies.

It has to decide whether to accept any one of these offers, or to continue operating by itself. Since all the alternatives for the decision are fully known in full detail, it is not necessary to construct a mathematical model to identify the set of all alternatives for the decision in this category. Instead, one can begin applying an algorithm for solving these problems directly. A specialized method known as the scoring method commonly used to handle these problems.

Category 2: This category includes all decision problems for which each possible alternative for the decision is required to satisfy some restrictions and constraints under which the relevant system must operate. Even to identify the set of all possible alternatives for the decision, we need to construct a mathematical model of these restrictions and constraints in this category. Even when there are no constraints to be satisfied in a decision problem, if the number of possible alternatives is either infinite, or finite but very large; it becomes necessary to define the decision variables in the problem, and construct the objective function (the one to be optimized) as a mathematical function of the decision variables in order to find the best alternative to implement.

So, the essential characteristic of a Category 2 decision problem is that in order to handle it we need to identify the decision variables in the problem and build a mathematical model of the objective function and/or the constraints in terms of the decision variables. The rest of this chapter deals only with this category of problems.

Quantitative Analysis for Solving Category 2 Decision Problems

made exclusively on intuitive judgement based on ... experience. But to survive and thrive in this highly competitive technological world of today it is essential to make decisions on a rational basis. The most rational way for decision making is through quantitative analysis which consists of the following steps.

1. Get a precise definition of the problem, all relevant data and information on it: The initial statement of the problem may be vague or imprecise. Study the relevent system and develop an accurate and complete statement of the problem. Quite often the problem undergoes many changes in successive discussions until its final version is agreed upon by all the decision makers involved. Two types of factors or variables may be affecting the system. These are:

Uncontrollable factors: Factors such as environmental factors which are random variables not under the control of the decision makers.

Controllable inputs: Factors whose levels can be controlled by the decision makers and set at desired values. These factors whose values the decision makers can manipulate are called decision variables in the problem. They may include other ancillary variables that are functions of the decision variables. If there are no uncontrollable factors, or if the values of all the random variables among the uncontrollable factors are known exactly, the relevant system depends only on the values of the controllable decision variables and there is no uncertainty, i.e., all the relevent data in the decision problem is known with certainty.

Decision making as a deterministic decision

In this case the decision problem is known as a deterministic decision making problem. When the random variables among the uncontrollable inputs are subject to variation, the decision problem is known as a stochastic or probabilistic decision making problem. Here the outcome of the relevent system is uncertain even when the values of all the decision variables are fixed, riables will not have their values known before the uncertainty must be incorporated into the decision making.

1. To solve a stochastic decision making problem, we need knowledge of the probability distributions of all the random variables among the uncontrollable inputs. Unless the decision problem is a very simple one, exact analysis of it using these probability distributions may become very complex. That's why very often stochastic decision problems are analyzed by studying appropriate deterministic approximations of them.
One commonly used hedging strategy to construct a deterministic approximation of a stochastic decision making problem is to replace each random variable by some location parameter of its probability distribution (mean, median, or some desirable percentile) plus some safety factor to account for the uncertainty in its value. This converts the problem into a deterministic decision making problem.
That is why studying techniques for solving deterministic decision making problems is of great importance. In this book we will discuss only deterministic decision making problems.

2. Construct a mathematical model of the problem: Construct a mathematical model that abstracts the essence of the decision problem. The model should express the various quantities in the problem including performance measures if any, in the form of mathematical functions of decision variables, and express the relationships among them using appropriate equations or inequalities, or objective functions to be optimized (maximized, or minimized, as appropriate).
Real world problems are usually too complex to capture all the fine details of them in the form of simple mathematical models that we can analyze. This is also applicable to educational planning. Usually a model is a simplification that provides a sufficiently precise representation of the main features such that the conclusions obtained from it also remain valid to he original problem to a

ximation. Therefore, constructing a mathematical aking approximations, heuristic adjustments, and quite often ignoring (or putting aside or relaxing) features that are difficult to represent mathematically and handle by known mathematical techniques. When such relaxations are used, it may be necessary to make some manual adjustments to the final conclusions obtained from the model to incorporate the relaxed features.

It usually takes great skill to decide which features of the real problem to relax in constructing a model for it, this skill comes from experience. This is reflected in the word “mahaanubhaava” in Indian languages like Sanskrit, Telugu etc. for “great person or expert”, which literally means “a person of vast experience”. That’s why many people consider modeling to be an art.

3. Solve the model: Solve the model to derive the solution, or conclusion for the decision problem. For some of the models we have efficient algorithms and high quality software systems implementing them. For some others we do not yet have efficient algorithms, and when the model is large, existing algorithms might take unduly long to solve it. In this case, one usually obtains approximate solutions using some heuristic approaches.

4. Implement the solution: In this final phase, the solution obtained is checked for practical feasibility. If it is found to be impractical for some reason, necessary modifications are carried out in the model and it is solved again; the same process is repeated as needed.

Often the output from the model is not implemented as is. It provides insight to the decision maker(s) who combine it with their practical knowledge and transform it into an implementable solution.

A Model for a Simp le Decision Making Problem

Modern jogging shoes usually contain heel pads for cushioning to soften the impact when the foot hits the ground, and also to give some bounce.

eel pad is a sealed packet of plastic containing owing type of decision problem arises at companies making these heel pads.

Decision problem: There is 100 cc of a gas at 1500 mb of pressure in a closed container. Determine how much gas should be added to or expelled from the container to make sure that when the gas in the container is compressed to 3000 mb of pressure its volume will be 40cc.

The only decision variable in this problem is:

x = cc of gas to be added to or taken out of the present container. We adopt the convention that positive values of x indicate addition of gas to the container (i.e., for example, x = 12 means adding 12cc of additional gas at 1500 mb of pressure to container), and negative values of x indicate expelling of present gas from container (i.e., for example, x = −8 means expelling 8 cc of gas from present container).

A solution to this decision problem consists of obtaining a numerical value to the decision variable x. After implementing the solution x, the container will have 100 + x cc of gas at pressure 1500 mb. Modeling Requirement to be met: When the contents 100 + x cc in the container are compressed to 3000 mb, the volume of gas in the container should be 40 cc.

This requirement leads to a constraint that the decision variable x should satisfy. There are two important characteristics of gas in this problem, its pressure p in mb, and volume v in cc, which are ancillary variables. Determining the constraint on the decision variable needs an understanding of the relationship between p and v, i.e., as compression increases the value of p, how does the volume v vary?

We denote the volume of gas in the container at pressure p by v(p). This relationship is provided in the form of an equation by Boyle's Law of physics which states that the pressure p and volume v(p) of a fixed quantity (by weight say) of gas satisfy pv(p) = a constant a say.

where the constant a in the RHS depends on the quantity of gas.

es not hold exactly. But it offers a very good p) behave in the range of values of these variables encountered in this application, so we will use it. So, v(p) = a/p. In our decision problem we know that v(1500) = 100 + x. Substituting, we find that a = 1500(100 + x). So we have v(p) =150, 000 + 1500xp

This provides the volume of gas in the container as a mathematical function of its pressure. The requirement is that v(3000) = 40. This can be expressed as the constraint 150, 000 + 1500x = 3000 × 40, or 1500x = −30, 000

This is a single linear equation in the decision variable x, it constitutes the mathemtical model for our decision problem. The left hand side of this constraint, 1500x, is known as the constraint function and the right hand side constant −30, 000 is abbreviated and called the RHS constant for the constraint.

This model has the unique solution x = −30, 000/1500 = −20 which is the only value of the decision variable x satisfying the requirement. It is the solution for our decision problem; it corresponds to the action of releasing 20cc of gas from the container at original pressure of 1500 mb.

3.4 General Criticism

A general criticism of decision theory based on a fixed universe of possibilities is that it considers the "known unknowns", not the "unknown unknowns": it focuses on expected variations, not on unforeseen events, which some argue (as in black swan theory) have outsized impact and must be considered – significant events may be "outside model". This line of argument, called the ludic fallacy, is that there are inevitable imperfections in modeling the real world by particular models, and that unquestioning reliance on models blinds one to their limits.

4.0 CONCLUSION

Decision theory has been examined as a normative or prescriptive, *i.e.*, it is concerned with identifying the best decision to take, assuming an ideal

... informed, able to compute with perfect accuracy, ...tical application of this prescriptive approach (how people *actually* make decisions) is called decision analysis, and aimed at finding tools, methodologies and software to help people make better decisions, especially in Educational Planning.

5.0 SUMMARY

Decision theory in mathematics and statistics is concerned with identifying the values, uncertainties and other issues relevant in a given decision and the resulting optimal decision. It is sometimes called game theory. Normative and descriptive decision theory, what kinds of decisions need a theory? Choice under uncertainty, intertemporal choice, Competing decision makers and Complex decisions were the various kind of decision theory.

6.0 TUTOR-MARK ASSIGNMENT

1. What kinds of decisions need a theory?

2. In a tabular form, discuss the statistical decision theory in relation to Education.

3. Decision theory stands to be an effective and efficient approach to Educational Planning. Discuss.

7.0 REFERENCES / FURTHER READINGS

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