COMPUTERISATION OF THE MANAGEMENT SCIENCE TECHNIQUE OF REPLACEMENT ANALYSIS.

A CASE OF SUDDEN FAILURE ITEMS

BY

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SEPTEMBER' 2000

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APPROVAL PAGE

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ABSTRACT

Management science (the application of a scientific approach to solving management problems in order to help managers make better decisions) encompasses a number of mathematically oriented techniques, like linear mathematical programming techniques, network techniques financial analysis (replacement analysis) techniques, inventory techniques, probabilistic techniques etc.

These techniques can be applied to solve problems in a variety of different types of organisations including government, military, business and industry, and health-care though they are predominantly used in business. The success rate in situations where these techniques are used have been quite high.

In teaching these techniques emphasis has always being on manual solutions to the techniques both in the classroom and in textbooks. Where there are computerised solutions they are limited to linear mathematical programming techniques and a few others.

In this project, an attempt is made to provide a computerise solution to the management science technique of REPLACEMENT ANALYSIS with emphasis on replacement problems involving sudden failure items.

DEDICATION

I dedicate this work to my parents Mr. and Mrs Ishaku Kura, the foundation of my education.

ACKNOWLEDGEMENT

My gratitude goes to the Almighty God for making the writing of this project possible. I also wish to thank my supervisor professor K.R. Adeboye for his time and effort in painstakingly going through this work to bring out the best in me and also my lecturers who taught me, Dr. S.A. Reju, (HOD), Mr. L.N. Ezeako (course co-ordinator), Dr. Yomi Ayesimi, Dr. P.O.Badmus, Mr. Audu Isah, Mr. Adewale I.K, Mrs. Agbachi N.U, Mr. Ohwobete Jabo.

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CHAPTER ONE

1.0 INTRODUCTION

Management science, operations research, quantitative methods, quantitative analysis, quantitative techniques, decision sciences, by whatever name it may be called refers to the same discipline. It is a scientific approach to solving management problems in order to help managers make decisions. It encompasses a number of mathematically oriented techniques like linear programming techniques, inventory control techniques, network techniques, probabilistic techniques replacement analysis techniques etc. These techniques have either being developed within the field of management science or adapted from other disciplines like mathematics (calculus), statistics (probabilistic techniques) to mention a few.

The application of management science techniques is widespread. Though predominantly used in business they are not restricted to business but also in government, military and healthcare. They have also being credited with increasing the efficiency and productivity of businesses. Today Management Science is studied as either a course on its own or part of the curriculum of a course like business courses computer science etc.

Management Science techniques do not actually make decisions but provide information that can aid the manager in making decisions. This information is the results or solutions of management science techniques models.

The manager uses his skill and experience together with the information from management science techniques to make decisions. As indicated earlier management science encompasses a logical systematic approach to problem solving. This approach follows the steps below:

1. Observation - The system is closely observed so that problems can be identified as soon as they occur or are anticipated.
2. Definition of the problem - The problem identified must be clearly and concisely defined. An improperly defined problem can easily result in no solution or an inappropriate solution.
3. Model construction - It is an abstract representation of an existing problem situation. It can be in the form of a graph or chart or most frequently as a set of mathematical relationships.
4. Model solution - A management science technique solution usually applies to a specific type of model. Thus the model type and solution are both part of the management science technique.
5. Implementation of results - The manager combines the information (model solution/results) with his own experience and expertise in making the ultimate decision.

Most organisations have a formalised information system to accumulate, organise and distribute information for decision making purposes called a management information system (MIS).

A management information system is designed to channel large quantities and numerous types of information through an organisation.
Data is collected, organised, processed and made conveniently accessible to the manager so that the information can be of assistance in the manager's daily operations. The components of a management information system are; the database, the computer system and the form in which the data is distributed. Much of the information is often in the form of reports or management science techniques results/solutions. The database contains items such as prices, production output and rates, available resources number of orders, capacities and labour rates. For an efficient and affective management information system the database must contain relevant and quality information, the right type and should be enough. The information in the database must be properly organised. Since most modern organisations have access to such a large quantity and variety of information the use of computer is required.

A decision support system (DSS) - a subsystem of a management information system - supports the manager in the decision making process. In a decision support system the manager acts as an internal component. In other words the manager interacts with the computer based information system such that decisions are reached by an interactive process. A decision support system frequently integrates management science models within its framework. The computer generates the results of a management science model and

the manager might ask the computer what if something were changed in the model. The manager might then ask the computer for new results based on this change. Such experimentation with possible changes educates the manager regarding possible courses of action that can be taken as a result of occurrences in the future.
The manager can also test the possible decisions to see their potential results before actually making them.

1.1 STATEMENT OF THE PROBLEM

In management science textbooks and classes where students are taught management science techniques emphasis is on how to use the techniques manually. Computerise techniques are few and usually limited to linear programming.
The lack of computerise techniques limits our taking advantage of the attributes of a computer which include the ability to do calculations faster than human beings, ability to store and retrieve information, accuracy and less human effort.
The lack of computerise techniques limits our ability to have an efficient and effective decision support system, since it limits our degree of interaction with the system because much effort will be required in providing results based on changes made.
The lack of computerise techniques also limits our ability to have an efficient and effective management information system. Our ability to channel large quantities and numerous types of information through the organisation will be limited.

1.2 PURPOSE OF THE STUDY

The purpose of this study is to computerise replacement analysis technique (a management science technique) for solving replacement problems involving sudden failure items or components to form part of a management information system or a decision support system. The study is in partial fulfillment of the requirement of the Federal University of Technology Minna for the award of a post graduate diploma in computer-science.

1.3 ASSUMPTIONS OF THE STUDY

In this study the following assumptions are made:-

1. The data required for the use of the technique is readily available.
2. A personal computer will be used in processing the data.
3. The user of the technique is a management scientist or someone with the knowledge of management science techniques and is computer literate.
4. The technique is already in use (manually) or about to be introduced.
5. The computerise technique will be used either in a classroom, business or industry.
6. Depending on the situation there is or there is no management science department where the technique is used.
7. The environment where the technique will be used is computerised or about to be computerised and all controls and security measures required in a computer environment are in place hence

only those controls and security measures required for this technique will be considered in this study.

1.4 SCOPE AND LIMITATION OF THE STUDY

The scope of this study will include:-

(1) An overview of replacement problems generally, what an optimum replacement strategy is, how to use replacement analysis to solve replacement problems involving sudden failure items and the data required for the technique.

(2) A look at what management information system and decision support system are, their components, the attributes required to make them effective and efficient and how the work.

(3) A look at how the computerise technique of replacement analysis for sudden failure items could form part of a management information system or decision support system.

(4) A look at how the data required for the technique will be collected, entered into the computer system and how it will be processed. The controls and security measures necessary for the integrity of the data used and information produced will be looked into.

(5) A program containing instructions on how the computer will produce the results of the technique will be written with a

justification of the programming language used, how the program will be implemented and maintained and the reports that will be produced.

1.5 DEFINITION OF TERMS

ACCESS:- The ability to work with files.

ACCESS CONTROL:- The management of rights to use resources.

APPLICATION PROGRAM:- In general a program that is designed to perform a specific user function.

AUTHORISED USER:- A person or organisation authorised to use a system.

BACK-UP:- The hardware and software resources available to recover after a degradation or failure of one or more system components or to copy files onto a second storage device so that they may be retrieved if the data on the original source is accidentally destroyed.

BUG:- An error in a program or a malfunction in a piece of equipment.

CODE:- The statements that make-up a computer program.

COMPILER:- A computer program used to convert symbols meaningful to a human operator into codes meaningful to a computer.

COMPUTER:- An electronic system which in accordance with its programming will store and process information as well as perform high-speed mathematical or logical operations.

DATA:- Any material which is represented in a formalized manner so that it can be stored manipulated and transmitted by machine

DATABASE:- A collection of data stored electronically in a predefined format and according to an establish set of rules.

DATA COLLECTION:- Procedure in which data from various sources is accumulated at one location before being processed.

DATA ENTRY:- Introducing data into a data processing or information processing system for input.

DATA INTEGRITY:- A measure of data communi.. performance indicating sparsity or absence of undetected errors.

DISK:- An electromagnetic storage medium for digital data.

DOCUMENTATION:- A written description of a program that includes its name, purpose, how it works and frequently operating instructions.

FILE:- A collection of records.

FLOPPY DISK:- A flexible plastic 3½ or 5¼ inch disk located with magnetic materials and used to store data.

FLOW-CHART:- A chart to represent the flow of data or instructions through a process including decision points and loops where appropriate often used for designing and documenting computer programs.

FUNCTION - A standard, pre-packaged set of coded instructions for carrying out a computer operation.

GARBAGE - An informal term used to refer to corrupted data.

HARDWARE - Equipment (as opposed to a computer program or a method of use) such as mechanical, electrical, magnetic or electronic devices.

INFORMATION - The meaning assigned to data by people.

INPUT - The data to be processed. The device or collective set of devices. The process of transferring data from an external storage to an internal storage.

INTERACTIVE - An operation where a user typically enters data and awaits a response message from the destination prior to continuing.

MAINTENANCE - An activity intended to eliminate faults or to keep hardware or programs in satisfactory working condition.

MENU - An organised collection of captions (field headers) and fields to accept variable data associated with each caption.

NETWORK - A series of points connected by communication channel.

OPERATING SYSTEM - A program that manages a computer's hardware and software components. It determines when to run a program and controls peripheral equipment such as printers.

OUTPUT - Data that has been processed.

PASSWORD - A word or character string that when accurately presented permits a user access to a system or computer program.

PERSONAL COMPUTER - A microcomputer with an enduser oriented application program for an assortment of functions.

PROGRAM - A sequence of step-by-step instructions that tell a computer what to do.

SECURITY - The techniques used for preventing physical assess to information. May involve the use of encryption.

SOFTWARE - A computer program or set of programs held in some kind of storage medium and loaded into memory for execution.

SOFTWARE MAINTENANCE - The continual improvements and changes required to keep programs up to date and working properly.

TERMINAL - A device for sending and/or receiving data.

USER - Anyone who requires the services of a computer system.

VALIDATION - Checking data for correctness or compliance with applicable standards, rules or conventions.

CHAPTER TWO

2.0 REPLACEMENT ANALYSIS

2.1 INTRODUCTION TO REPLACEMENT ANALYSIS

At one time in our lives we have had course to replace some of the assets or items we have e.g clothes, because of fashion, one celebration (Christmas, Sallah, Weddings or Birthdays) or another, or the ones we have, have been destroyed. Cars, because the one we have have is giving us problems or we want to change to a new model or another brand, a house because the one we has been destroyed by a catastrophe, we have need for a bigger one or a new design, Bulbs in our homes because they have failed, fan belts in our cars because they have failed too or fuses, I.cs in electrical appliances that suddenly fail and have to be replaced.

Just as we have items, components or assets as individuals that we need to replace from time to time so are companies, businesses, factories, industries and organisations that have assets that they need to replace. Machinery because they are worn-out, destroyed or an improved version is needed. Buildings because there is need for a bigger one, a new design or the old one has been destroyed.
Some of the components of the machinery in industries could also fail and need replacement so also company vehicles.
The cost of replacing these assets could be enormous talkless of the inconveniences they could cause because of their failure e.g failure of a conveyor belt in a factory could stop production completely.

Because of these costs and inconveniences some organisations embark on a deliberate policy of the time interval to take before replacing their assets after taking into consideration certain factors. Replacement analysis technique assist organisations in making their replacement policies. It will be good to note that it is not all replacement problems stated above that replacement analysis helps us to solve.

Replacement analysis involves the study of the various costs associated with each time interval which we are considering as the possible time interval to choose as our replacement cycle. The cycle with lowest cost is chosen as the optimum replacement cycle.

2.2 LITERATURE REVIEW

Professor R. Adeboye of the department of maths/computer Federal University of Technology Minna in his lecture notes on operations research page 44 on the topic replacement and maintenance problems introduces the topic thus, "Many system deteriorate as time goes on unless some corrective action is taken. In some cases parts of a system fail suddenly and unpredictably and the only corrective action possible is to replace them. For example a labour force deteriorates as people leave and hence replacement or recruitment may be necessary". He goes on to say "once the data about this deterioration have been collected the time when it becomes economic to replace the system with an associated capital cost can be calculated". When giving an example of a system that fails he wrote "A classic example of this kind of replacement is the case of the light bulbs".

Accountancy Tutors (Nig) Ltd, a tutorial school in accountancy based in Kaduna in its tutorial notes on the subject Financial Management defined replacement analysis thus "Most items of equipment (i.e. components, parts vehicles, machinery etc.) need replacement at sometimes or the other. Replacement analysis is the process by which the various cost consequences involved are studied so that the optimum replacement decision can be taken".

Mayo/BPP ICAN study text on financial management page 197 paragraph 2 writes. "The major problem with replacement is not so much should the asset be replaced?, but rather 'when or how frequently should the asset be replaced?.

Accountancy Tutors (Nig) Ltd while writing about the types of replacement problems wrote, "the 2 most common replacement problems relate to:-

(a) Sudden failure;

There are various parts or components that work adequately up to a point and then fail e.g.

* Fan belts.
* Electric bulbs
* Tyres etc

(b) Gradual deterioration:-

These are usually relatively expensive items which could be kept functioning with increasing amounts of maintenance e.g.

* Vehicles.
* Boilers.

They wrote this again about sudden failure items "often these items are inexpensive in themselves but the cost consequence of their failure and/or the installation costs involved in replacing them can be considerable. It is therefore necessary to estimate the various costs involved and choose the least cost position. The three categories of cost are:-

*The replacement cost of the item: usually the purchase price at the time of replacement.

*The consequential costs of failure which might be trivial say if an electric bulb failed but could be substantial if a small component failure caused an assembly line stoppage.

*The costs involved in the actual replacement of the item because of location and/or accessibility problems consideration is often given to group replacement at intervals or on the failure of one item. For example if a single electric bulb failed in an overhead lamp cluster in a factory then all the bulbs might be replaced at the same time even if many re still functioning.

As a result of the need to minimise the various costs involved several decisions alternatives are usually explored and the least cost alternative chosen".

2.3. TYPE OF REPLACEMENT PROBLEMS

The 2 most common replacement problems solved by replacement analysis relate to:-

(a) Assets that deteriorate gradually and

(b) Assets items, or components that suddenly fail.

GRADUAL DETERIORATION ASSETS

These are assets that because of usage with time they wear and their functioning capability deteriorate. To keep them functioning increasing amounts have to be spent on operating and maintaining them. A good example is a car, as it grow older it gives more problems and more is spent to maintain it, and functions less than when it was new. Please note that my concern is not with this type of replacement problem as one is faced with the problem of when it will be economical to replace this type of asset.

SUDDEN FAILURE ITEMS

These type of items work adequately but at a certain point they fail to function completely. A good example is an electric bulbs, it provides light up to a certain point it fails to do so and have to be replaced. Other examples include fuses and fan belts. These are items that are inexpensive at times but their failure could disrupt our activities like a bulb not providing light, a car fan belt not turning the car fan to cool the radiator etc. Replacement analysis is also concerned in helping to choose the optimum time to replace this type of items (which of course is my main concern).

that could fail in each cycle and the associate cost of replacing them.

(v). The total number of components under consideration.

2.5 OPTIMUM REPLACEMENT STRATEGY

After gathering the data on the various costs and life span of item comes the question of how these could be used to arrive at the optimum replacement strategy. In choosing a replacement strategy various alternatives strategies are considered. For each strategy these costs (if the cost applies to that strategy) are added up, the strategy with the lowest total costs is the optimum replacement strategy i.e. the item should be replaced after the interval in the optimum strategy.

For example, assuming a machine contains 50 components whose maximum life span is 4 weeks, the various alternatives are:-

(a). Replace on failure only.

(b). Replace on failure and all components after 1 week.

(c). Replace on failure and all components after 2 weeks.

(d). Replace on failure and all components after 3 weeks.

(e). Replace on failure and all components after 4 weeks.

The total costs in each alternative are found and the alternative with the lowest cost is the optimum. If it is b that is the optimum then the component will be replaced every time any fails and all components to be replaced after 2 weeks, even if it was replaced within the two weeks or it did not fail at the end of the 2 weeks.

2.6 CHOOSING A REPLACEMENT STRATEGY FOR SUDDEN FAILURE ITEMS MANUALLY.

An example will be used to illustrate how replacement analysis is used in the choice of an optimum replacement strategy.

EXAMPLE:-

The authorities of the Aminu Kano International Airport in Kano are considering a replacement strategy for its illuminating bulbs at the airport. The following data has being collected on the illuminating bulb life relating to normal operations.

Month after replacement	1	2	3	4	5
Percentage of original bulbs which have failed by the end of that month (cumulative).	10%	25%	50%	80%	100%

That is to say the bulbs have a maximum life span of 5 months. They could be replaced by new bulbs on a mass replacement basis for N30.00 per bulb. Alternatively they may be replaced individually as they fail at a cost of N120.00 per bulb. In each case the actual cost of the bulb itself is N15.00 the remainder representing labour and overhead. At present the organisation replaces bulbs as the fail.

Solution:-

STEP 1:- Alternatives involved include:-

(1). Replacement on failure only.

(2). Replace on failure and all bulbs at the end of month 1.

(3). Replace on failure and all bulbs at the end of month 2.

(4). Replace on failure and all bulbs at the end of month 3.

(5). Replace on failure and all bulbs at the end of month 4.

(6). Replace on failure and all bulbs at the end of month 5.

STEP 2:- Calculation of average life span of Bulbs.

Month n	Percentage of original bulbs failing (cumulate) pn	Percentage of original bulbs failing at the end of each month p (Pn-Pn-1)	Expected Value. np
1	10%	10%	0.1
2	25%	15%	0.3
3	50%	25%	0.75
4	80%	30%	1.2
5	100%	20%	1.0
		$\sum np$ =	3.35

that is on average after 3.35months all 1000 bulbs fail, therefore for 1 month $\frac{1000}{3.35}$ = 299 bulbs fail

STEP 3:- Computation of number of bulbs that fail.

Alternative 1 = $\frac{1000}{3.35}$ = 299bulbs monthly.

Mont	1	2	3	4	5	Tot al	cum Tota
% of fail ure	10%	15%	25%	30%	20%		
Mont							
1	1000 100					100	100
2	100 10	1000 150				160	260
3	160 16	100 15	1000 250			281	541
4	281 28	160 24	100 25	1000 300		377	918
5	377 38	281 42	160 40	100 30	1000 200	350	1268

STEP 4:- Computation of Average monthly cost of each alternative replacement cycle.

(1) Altern ative	(2) Repl. on failure & all bulbs at end of month	(3) Number of bulbs failing	(4) Individua l cost	(5) Group cost (1000x 30)	(6) Total cost (4)+(5)	(7) Averag e cost (6)÷(2)
1	On failure only	299	299x120= 35,880	-	35,880	35880
2	1	100	100x120= 12000	30,000	42,000	42,000
3	2	260	260x120= 31200	30,000	61,200	30,600
4	3	541	541x120= 64920	30,000	94,920	31,640
5	4	918	918x120= 110160	30,000	140,160	35,040
6	5	1265	12268x120 =152160	30,000	182,160	36,432

Based on the average cost of each alternative, alternative 3 (replacement on failure and all bulbs at the end of month 2) has the lowest average cost (N30,600). Therefore alternative 3 is the optimum replacement cycle.

CHAPTER THREE

SYSTEM ANALYSIS AND DESIGN

In this chapter we will look at 2 types of information systems, management information system and decision support system and how the management science technique of replacement analysis for replacement problems involving sudden failure items can be incorporated or form part of a management information system or decision support system.

3.0. INTRODUCTION TO MANAGEMENT INFORMATION SYSTEM AND DECISION SUPPORT SYSTEM.

For the running of an organisation, those charged with the responsibility of running that organisation need information on the activities carried out by the organisation to see whether they are doing well or not, whether they are going according to plan or not, about decisions to be taken and about the outcome of decisions taken.

Most at times, a formal system of where and how the information is to be generated and channelled through the organisation and the form the information is to take, refferred to as the information system of the organisation is put in place. The information system could be manual (mostly for very small organisations) or computerised (modern day information systems).

There are different types of information systems. but I will be concerned with management information systems and decision support systems.

A management information system (mis) is a system specifically designed to channel different amounts and different types of information through an organisation. Data is normally collected about the activities of the organisation or any decision that is to be taken, processed, organised to be meaningful and made available to the decision maker or the person charged with the responsibility of running the organisation or carrying out the activity.

A modern management information system is made up of a data base, computer system and the form in which the information is to be distributed. The database consist of relevant numerical and non-numerical information about the activities of the organisation properly organised. The computer system consist of the hardware and the software. In a management information system, software packages as well as programs written by programmers internally are combined to form the management information system. The computer processes data as per the instructions in the program to generate information and this information is distributed through the organisation in whatever form the organisation decides. The information could be in the form of reports or the results of management science techniques. It could be on request or scheduled to be produced periodically or after a certain activity. The diagram below shows an illustration of a management information system.

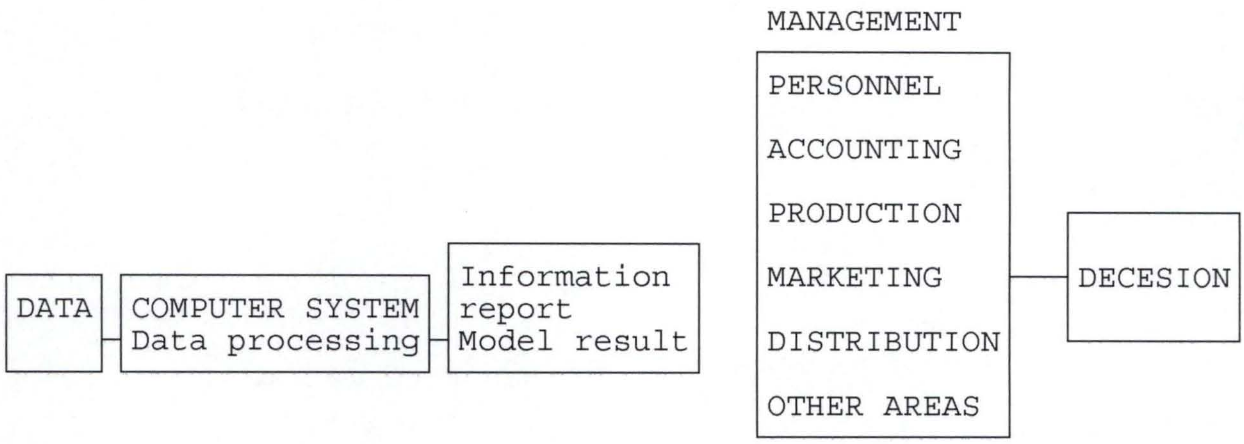

Fig 1. Illustration of a management information system.

In the diagram, data is collected and organised then processed through or by the computer system to generate information in form of reports or management science model results which are distributed to management for decision making. Decisions affect many departments in an organisation hence the flow of information between departments.

In a decision support system, the information system supports the manager in the decision making process. The manager interacts with the computer based information system such that a decision is reached by an iterative process.

A decision support system frequently integrates management science models within its frame-work. Below is a general frame-work of a decision support system.

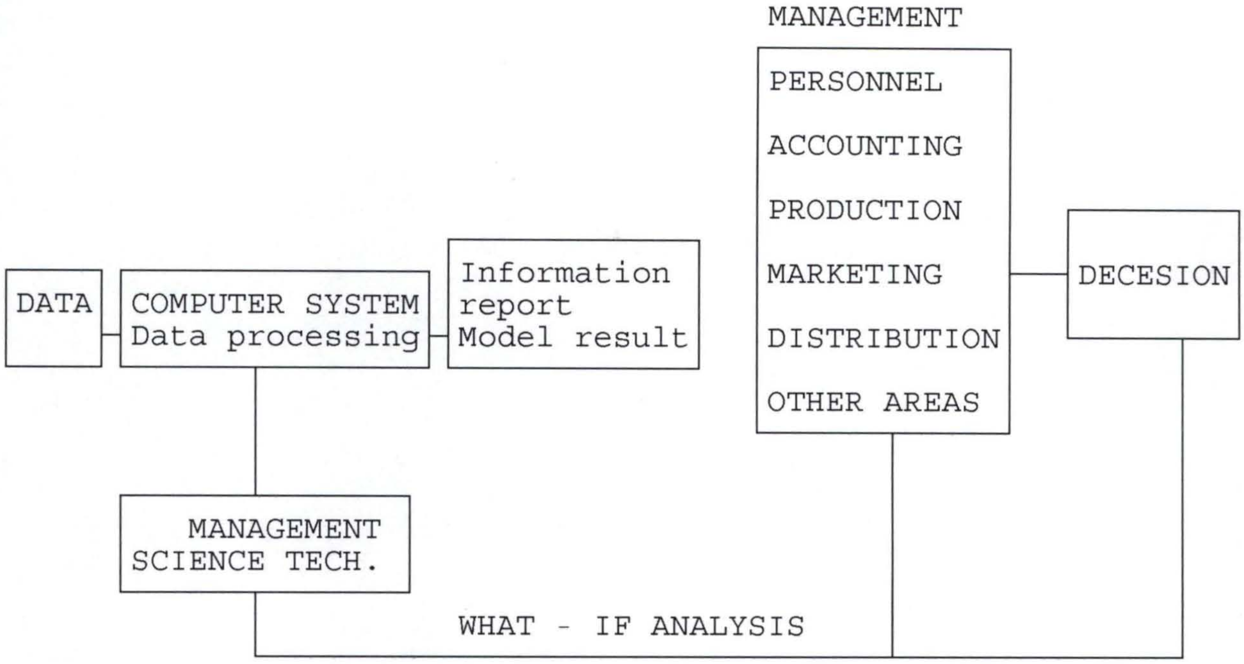

Fig 2. Illustration of a decision support system.

With the decision support system, it can be seeing from the diagram that its framework include that of the management information system with the addition of what-if analysis. The computer generates the results of management science models, the manager then introduces changes to the model by asking question in form of what-if so and so changes are introduced what will be the results. He could also want to see what the results of decisions taken will be. By so doing, the manager is well informed before making an actual decision. The decision taken provide a feedback to the data base hence it is an ongoing process. The interactive nature of the decision support system is achieved through programs written to ask for data in an interactive way. The interactive nature of decision support system makes the information generated to be on request only. Softwares like lotus 123, excel, lindo support the manager in his interaction with the information system.

3.1 MANAGEMENT INFORMATION

The computer in a management information system or decision support system processes data and generates information for use by the different units of the organisstion in question.

The information can take several forms e.g reports or the results of a management science model. For reports, data is summerised and organised in a useful and easily interpretable manner. Reports can be about accounts receivable (debtors), work force, inventory levels or production output, it can be about recent information or historical information, they can be at the request of management or on a regular basis as a matter of policy e.g the manager in-charge of personnel might request for the number of vacancies available in the organisation during a particular month, while a report on monthly salaries paid will be provided on a regular basis monthly.

Information can take the form of management science model results or solutions. Like reports, this information can be generated on a regular basis or on request. Frequently the information is at the request of the manager who wants the solution to a specific problem. It is to be noted that the management information cannot formulate the management science model itself, this must be accomplished by the manager, a management scientist or a management science staff skilled in management science techniques. The computer system can only provide the solution to the model that represent the problem.

3.2.0. INTEGRATION OF REPLACEMENT ANALYSIS IN A MANAGEMENT INFORMATION SYSTEM OR DECISION SUPPORT SYSTEM.

The aim of the management science technique of replacement analysis for replacement problems involving sudden failure items is to help the manager in making decision as to the optimum replacement strategy to use in replacing items components or assets that suddenly fail in the organisation. Various strategies are considered and their associated costs, in that the strategy with the least cost is taken.

The technique provides information to the manager about the cost of each strategy and the manager to make his decision based on the information provided by the technique.

To form part of the management information system data has to be collected for inclusion in the database, processed by the computer system and made available (i.e) the results, to the manager for him to make his decision. Hence data collection entry and processing will be considered alongside the management of data and files, controls and security measures, the reports of the system, the cost and benefits of computerising the technique and the position of the management scientist in the organisation.

3.2.1. DATA COLLECTION, DATA ENTRY AND DATA PROCESSING

DATA COLLECTION

This stage involves the collection of all relevant data required for the replacement analysis model. The data include, the number or quantum of items involved, the purchase price of the item, how long the item will last, the personnel and equipment cost to be used or incurred in the replacement process and the replacement periods under consideration. It is important that the data above is accurate. Inaccurate data will result in inaccurate information (model results), leading to inaccurate decision. The number of items, the life span of the item, the personnel and equipment and other direct and indirect cost could be got from the works department. The price of the item could also be from the works department or purchases department, depending on how the organistion is structured. The replacement periods under consideration could be agreed upon between the works and management science personnel.

DATA ENTRY

The data collected at the data collection stage is now entered into the system (i.e) the computer for processing. The data is read from documents by the person doing the entry and entered using the keyboard. A print-out of the data entered is made for comparison with data on the source documents to see that it is the correct data that is entered. It is assumed the data entry staff will be prompted by the computer to enter the data required for the solution of the model.

DATA PROCESSING

This stage involves the arithmetic calculations carried out by the computer in accordance with the program instructions to solve the replacement analysis model. The program is called using the keyboard by entering the path and program file name. The program now prompts the data entry staff for the data required then goes ahead to carry out the rest of the instructions contained in the program and finally brings out the solution to the model (replacement analysis model). The results of the model now form the information to be used by the manager in making his decision.

3.2.2 REPORTS FOR OPERATIONS AND DECISION MAKING

The computer generates the results or solution of the replacement analysis model showing the replacement periods under consideration, the number of items failing during the period and the number replaced, the total cost of the items replaced during the period and the average cost of replacement for the period.

This is displayed on the computer screen and printed copies made for filing or for onward delivery to the person to make the decision based on the results. The decision taken is communicated to the various department affected for necessary action.

3.2.3 FILE AND DATA MANAGEMENT

Apart from the normal files that contain source documents with the data used in solving the model all correspondences and any documents relevant to the making of the decision need to be documented and filed for future reference. This files need to be protected and maintained while in use. Other documents might be added in future and a policy be set on when or why it might be destroyed and responsibility assigned for its upkeep.

Apart from the files above, computer files are kept for the data, program and reports. Appropriate names need to given to this files for easier access. A directory could be created to contain all files that have to do with replacement analysis and may be sub-directories created each for data, program and report files. Back-up copies should be made of these files. The operating system assist any manipulations that will be done to this files as well as access control and protection. Adequate protection should be given to the storage medium containing these files.

3.2.4 CONTROLS AND SECURITY MEASURES

These include all measures taken or introduced to ensure the accuracy, total recording of all data relevant to the solving of the model avoid loss of data or improper entry and processing of data entered and that the program correctly solve the replacement analysis model and all the safeguards put in place to protect the assets of the information system. The measures include:-

(a) Ensure the accuracy of all data relevant to the solving of the model through:-

i. The organisation has approved and up to date catalogue of price list of items or a secured up-to-date computer file of the price list of items.

ii. Assign responsibility to the seeing that price list are accurate.

iii. Formally request for the number and life span of the item from the unit that is in a position to provide the information and insist that the head of the unit signs the document containing the information.

iv. Same for cost of personnel and equipment to be used in the replacement process.

v. Educate and stres the importance of the accuracy of data required vis-a-vis the decision that is to be taken to all parties involved.

(b). A print-out of data entered is compared with the source document.

(c). The program is well tested before implementation.

(d). Back-up copies of all computer files and put in fire proof cabinets.

(e). Restricted access to the computer.

(f). The computer housing environment should be cool and burglary proof.

(g). The integrity of the staff should not be mortgaged.

3.2.5 THE POSITION OF THE MANAGEMENT SCIENCE STAFF IN THE ORGANISATION.

The location of the management science department within an organisational structure, the size of the management science staff, the existence of a staff at all and the status of the management scientist are all factors affecting the degree of implementation of management science results. Many large and medium sized business firms have management science departments or staffs concerned exclusively with problem solving and model development.

These staffs can be quite large but their success is primarily dependant on quality.
The management science staff can exist at several locations within the organisation structure. It can be contained at the management level the corporate level or the operational level. Some firms have management science groups at each level of the organisation. The officer to whom the management science staff reports is basically determined by the location of the staff in the organisation. However, there does not appear to be a typical organisational location for a management science staff.

The above should not indicate that management science does not exist in firms where there is no management science staff or department. In many instances, a member or several members of the management staff will be versed in management science and apply management science techniques to their problems.

3.2.6 COSTS AND BENEFITS

Most at times this aspect is always overlooked. The cost in time and resources should not be overlooked. The financial cost, manpower requirements, staff skills and computer cost required to develop the model are costs that should be considered. The easiest cost to estimate are the direct manpower requirements necessary to develop the model, teaching management personnel the skill, the cost resulting from disruption of normal operating conditions, equipment cost and other cost that can be directly ascertained.

The benefits accruing from the computerisation of the technique include, time saved in solving the model, costs saved as a result of the use of the model and the resultant increase in profits. The stress of manual solutions is reduced and he benefits of well informed decisions should not be overlooked.

CHAPTER FOUR

4.0 PROGRAMMIMG

4.1 CHOICE AND JUSTIFICATION OF PROGRAMMING LANGUAGE

The programming language chosen in writing this computer application is DBASE which will be used in solving replacement problems involving sudden failure items, using replacement analysis (a management science technique), the subject of this project.

Though other programming languages like Basic, Pascal, Fontran, C++, C etc. could be used we feel more at home with the characteristics of DBASE which make it have an upper hand over others.

With Dbase, it is easy to state the exact spot we want data entered or displayed on the screen unlike Basic that you will have to use a series of comas or semicolons to achieve that, if ever. With Dbase you just state the row and column of the screen (the screen is divided into 80 columns and 25 rows) where you want your data entered or displayed.

With Dbase one can control the environment where the program can be run with the use of the various SET commands available in Dbase. One can set the colour of the screen make the status bar, or scoreboard be retained or disappear, set talk on or off among other set commands when the program is run.

The use of menus where a list of items or activities the program or application can perform are stated, and what the user need to do to activate the carrying out of that activity. This is not available in other programming languages or will be difficult to achieve.

Dbase is associated with database management applications it can also be used in non-database management environment unlike Basic, Fortran and Pascal among others that cannot be used in a database management environment.

However, Dbase has the disadvantage of not being run i.e. its applications directly from the DOS Prompt. This is because its files do not have the exe extension unlike other languages that have and thus can be run directly from the Dos Prompt.

4.2 PROGRAM AND PROGRAM DOCUMENTATION.

The program to carry-out the computer application of replacement analysis technique for sudden failure items with its associated documentation is included as an appendix. The documentation is made internally in the program.

4.3 **PROGRAM IMPLEMENTATION**

After installing this program on your personal computer which is better made on the hard-disk in the dbase management package (Dbase iv) It is advisable that copies of the program be made as a back-up and kept separately.

Implementation can be direct without problem because it has been tested and found working perfectly. However it can be implemented in conjunction with a manual solution to the problem at hand and both results compared only when satisfied then will the manual solution be done away with.

4.4 PROGRAM MAINTENANCE

Program maintenance is the term given to the changes made to a software system after it has been put into operation. It might be due to rectification of errors, adapting the software to changes in the environment it operates e.g new hardware, new operating system etc. It might be due to recommendations from users for new capabilities, general enhancement and modification to existing functions. It might also be to improve future maintainability or reliability or to provide a better basis for future enhancement.

Research has shown that the cost of maintenance is always high reaching as high as 60% of the software development budget hence it is an important aspect.

Depending on the organisation, maintenance department is at times created different from a software development department to carry out program maintenance. A very important aspect of software maintenance is an understanding of the program to be maintained. If the program is not understood instead of correcting errors more errors will be introduced and the aim of maintenance will be defeated.

This program has been written in a simple enough format for easy understanding and the internal documentation tries to explain each line of code in the program apart from a heading explaining what a particular segment is supposed to be performing. Hence in the absence of the producer of this program maintenance can be easily carried out.

CHAPTER FIVE

5.0 IMPLEMENTATION (PROBLEMS AND SOLUTIONS), SUMMARY AND CONCLUSION.

5.1 IMPLEMENTATION

The application of information (i.e results) from solving management science techniques models (Replacement Analysis technique inclusive) is referred to as implementation. The results of or solution of a management science technique is used in taking decisions as regards the problem under consideration.

Sometimes the result or solution is used in taking decisions, sometimes it is not. If it is not used then the effort in using the technique is defeated, moreso when cost are incurred.

In this section we will look at some of the causes of non-implementation of management science technique results.

5.11 CAUSES OF NON-IMPLEMENTATION

Many causes have been adduced to the non-implementation of the information generated by management science models. These causes lie in the relationship of the management science staff and the surrounding organisation. These include:-

(1) The support for management science in the organisation.

(2) The success of prior uses of management science.

(3) The amount of influence the management science staff has in the organisation.

(4) The size of the management science staff and the amount of resources it commands.

(5) The climate for innovation and change within the organisation.

(6) The time frame for decision making.

(7) The location of the responsibility for implementation.

(8) Management's experience with management science techniques, among others.

5.02 STRATEGIES FOR ACHIEVING SUCCESSFUL IMPLEMENTATION.

As we can see there is no one cause or set of causes for implementation failure as a result it is difficult to propose a specific strategy for ensuring implementation hence an implementation strategy must be tailored to fit the particular organisation. However, one common thing about all strategies is that, implementation should be a continuous ongoing process i.e implementation includes not only the final decision but also problem formulation, model development and construction and model testing.

By this, the experiences gained from implementation depends on success at each stage of the modelling process. If the management problem is not formulated properly, if the model is constructed improperly, if the results are not realistic or applicable then implementation will never occur. If management is involved in the management science process i.e active participation in the development and use of the management science model, then there is a better chance that the model will be designed with the proposed use closely in mind and the model will not be too sophisticated for the user.

If a situation is created in which the manager is conducive to change then we could achieve successful implementation. This is based on the fact that for the manager, lack of change promotes stability and continuity leading to feelings of comfort and safeness when changes becomes imminent it is resisted since it is perceived as a threat to normal safe routine of the manager. In this scenario the management science technique is a potential change (moreso it is computer - based) since it often represents a new and different way of doing things. Therefore an organized process must be established to overcome resistance to change and to create a new feeling of routine that will reinforce the use of the model.

5.2 CONCLUSION

Though an attempt has been made to provide a computerised solution to replacement problems using replacement analysis (a management science technique for solving replacement problems) because of the benefits of computerization all this effort could go to naught if the information is not implemented. Hence effort should be made to see that results of the technique are implemented and not just incurring cost without benefit.

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APPENDIX 1

```
*INTRODUCTION OF PROGRAM AND SETTING OF ENVIRONMENT WHERE PROGRAM WILL BE RUN

set talk off
set status off
set scoreboard off
PUBLIC item,indcost,lspan,interval
lspan = 4
@ 5,0 to 22,75 double
@ 8,13 say "WELLCOME TO REPLACEMENT ANALYSIS"
@ 10,13 say " (for sudden failure items)"
@ 14,13 to 14,18
@ 14,20 say "a management science technigue"
@ 16,20 say "for solving replacement problems"
@ 18,20 say "involving items/components that"
@ 20,20 say "suddenly fail e.g light bulbs, fuses, etc."
wait
@ 8,0 clear to 21,59
@ 6,13 say "REPLACEMENT ANALYSIS"
@ 10,20 say "A program written by THOMAS ISHAKU"
@ 12,20 say "PGD\MCS\555\97\98, in partial fullfilment"
@ 14,20 say "of the reguirement of the department"
@ 16,20 say "mathematics\computer-science, F.U.T. MINNA"
@ 18,20 say "for the award of P.G.D. in computer science."
wait
@ 10,0 clear to 19,79

*DATA ENTRY(name of item or component)

name = space(20)
@ 10,10 say "ENTER NAME OF ITEM\COMPONENT and press ENTER to continue"
@ 12,10 get name
read
@ 10,10 clear to 12,74
@ 10,26 say "NAME OF ITEM IS"
@ 10,42 say name
wait
@ 10,0 clear to 11,62


*DATA ENTRY(number of items involved)

DO WHILE .T.
   item = 0
   @ 10,10 say "ENTER TOTAL NUMBER OF ITEMS\COMPONENTS INVOLVED"
   @ 12,10 say "and press ENTER to continue"
   @ 16,10 get item
   read
   @ 10,10 clear to 16,74
   @ 10,10 say "TOTAL NUMBER OF ITEMS = "
   @ 10,35 say item
   choice = space(1)
   @ 12,10 say "confirm figure, if correct press 'Y' or 'N' for correction"
   @ 12,70 get choice
   read
   @ 10,10 clear to 12,74
   if choice = "Y"
       exit
   endif
ENDDO

*DATA ENTRY(individual item replacement cost)
```

```
DO WHILE .T.
   indcost = 0
   @ 10,10 say "ENTER INDIVIDUAL ITEM REPLACEMENT COST"
   @ 12,10 say "and press ENTER to continue"
   @ 14,10 get indcost
   read
   @ 10,10 clear to 14,74
   @ 10,10 say "INDIVIDUAL ITEM REPLACEMENT COST = "
   @ 10,46 say indcost
   choice = space(1)
   @ 12,10 say "confirm figure, if correct press 'Y' or 'N' for correction"
   @ 12,70 get choice
   read
   @ 10,10 clear to 12,74
   if choice = "Y"
      exit
   endif
ENDDO

*DATA ENTRY(mass replacement cost)

DO WHILE .T.
   masscost = 0
   @ 10,10 say "ENTER MASS REPLACEMENT COST PER ITEM"
   @ 12,10 say "and press ENTER to continue"
   @ 16,10 get masscost
   read
   @ 10,10 clear to 16,74
   @ 10,10 say "MASS REPLACEMENT COST PER ITEM = "
   @ 10,43 say masscost
   choice = space(1)
   @ 12,10 say "confirm figure, if correct press 'Y' or 'N' for correction"
   @ 12,70 get choice
   read
   @ 10,10 clear to 12,74
   if choice = "Y"
      exit
   endif
ENDDO

*DATA ENTRY(life-span of item)

DO WHILE .T.
   lspan = 0
   @ 10,10 say "ENTER LIFE-SPAN OF ITEM"
   @ 12,10 say "and press ENTER to continue"
   @ 14,10 get lspan
   @ 14,15 say "DAYS\MONTHS\YEARS"
   read
   @ 10,10 clear to 14,74
   @ 10,10 say "LIFE-SPAN OF ITEM = "
   @ 10,34 say lspan

   choice = space(1)
   @ 12, 10 say "confirm figure, if correct press 'Y' or 'N' for correction"
   @ 12,74 get choice
   read
   @ 10,10 clear to 12,74
   if choice = "Y"
       exit
   endif
```

```
ENDDO

*DATA ENTRY(length of interval between periods)


DO WHILE .T.
    interval = 0
    @ 10,10 say "ENTER INTERVAL BETWEEN PERIODS"
    @ 12,10 say "and press ENTER to continue"
    @ 14,10 get interval
    @ 14,15 say "DAYS\MONTHS\YEARS"
    read
    @ 10,10 clear to 14,74
    @ 12,10 say "INTERVAL BETWEEN PERIODS = "
    @ 12,37 say interval

    choice = space(1)
    @ 14,10 say "confirm figure, if correct press 'Y' or 'N' for correction"
    @ 14,74 get choice
    read
    @ 10,10 clear to 14,74
    if choice = "Y"
        exit
    endif
ENDDO

*MENU TO DISPLAY CHOICE OF ENTRY OF FAILURE RATE DATA



    @ 12,25 say "FAILURE RATE ENTRY MENU"
    @ 13,25 to 13,59 double
    @ 15,17 say "TASK-CODE"
    @ 15,32 say "TASK"
    @ 16,17 to 16,25
    @ 16,32 to 16,35
    @ 18,21 say "1" + space(7) + "ENTRY--NUMBER OF FAILURES"
    @ 19,21 say "2" + space(7) + "ENTRY--CUMULATIVE NUMBER OF FAILURES"
    @ 20,21 say "3" + space(7) + "ENTRY--PERCENTAGE/PROBABILITY OF FAILURES"
    @ 21,21 say "4" + space(7) + "ENTRY--CUMULATIVE PERCENTAGE/PROBABILITY OF FAILURE"

    A = 0
    @ 23,19 say "ENTER A TASK - CODE"
    @ 23,38  get A picture "9" range 0,4
    read
    DO CASE
        case A = 1
           DO num
        case A = 2
           DO cumnum
        case A = 3
           DO ptgprob
        case A = 4
           DO cumptgpr

    ENDCASE
    @ 12,17 clear to 23,79

*CALCULATION OF NUMBER OF ITEMS THAT FAIL IN A PARTICULAR PERIOD
*BASED ON FAILURE RATE ENTERED


DECLARE fail[lspan],cumfail[lspan],circost[lspan],tpdcost[lspan]
```

```
DECLARE avprdcost[lspan]
period = 1
startprd = 1
DO WHILE startprd <= lspan
fail[period] = 0
period = period + 1
startprd = startprd + 1
ENDDO
period = 1
startprd = 1
DO WHILE startprd <= lspan
      fail[period] = item * prob[period]
      k = 1
      n = 1
      sfail = 0
      DO WHILE k <= lspan
          z = period - n
         IF Z > 0

          sfail = sfail + fail[z] * prob[n]
        ENDIF
           k = k + interval
           n = n + 1
      ENDDO
      fail[period] = fail[period] + sfail
      q = period - 1
      IF Q > 0
         cumfail[period] = cumfail[q] + fail[period]
      ELSE
         cumfail[period] = fail[period]
      ENDIF

     period = period + 1
      startprd = startprd + interval

ENDDO



*CALCULATION OF COSTS

period = 1
startprd = 1
tmrcost = item * masscost
DO WHILE startprd <= lspan
      circost[period] = cumfail[period] * indcost
      tpdcost[period] = circost[period] + tmrcost
      avprdcost[period] = tpdcost[period]/period
      period = period + 1
      startprd = startprd + interval
ENDDO



*DISPLAY OF REPLACEMENT FIGURES

PRINTJOB
prd = 1
sprd = 1
@ 12,30 say "REPLACEMENT FIGURES"
@ 13,30 to 13,49
@ 14,10 say "AVERAGE PERIODIC REPLACEMENT ON FAILURE ONLY = "
```

```
@ 14,55 say avfailure
@ 16,3 say "PERIOD"
@ 16,13 say "REPLACEMENT ON FAILURE"
@ 16,38 say "CUMULATIVE REPLACEMENT"
@ 16,61 say "MASS REPLACEMENT"
R = 18
DO WHILE sprd <= lspan
     @ r,1 say prd
     @ r,13 say fail[prd]
     @ r,38 say cumfail[prd]
     @ r,61 say item
     r = r + 1
     prd = prd + 1
     sprd = sprd + interval
     if r = 21
          wait
          r = 18
          @ 18,1 clear to 22,74
     endif
ENDDO
wait
@ 12,1 clear to 22,74


*DISPLAY OF COSTS

pd = 1
spd = 1
@ 10,30 say "COSTS"
@ 11,30 to 11,35
@ 12,10 say "AVERAGE PERIODIC REPLACEMENT ON FAILURE ONLY COST = "
@ 12,62 say cost
@ 14,3 say "PERIOD"
@ 14,13 say "INDIVIDUAL REPLACEMENT COST"
@ 14,42 say "MASS-COST"
@ 14,52 say "TOTAL COST"
@ 14,63 say  "AV. PERIOD-COST"
r = 15
DO WHILE spd <= lspan
      @ r,1 say pd
      @ r,15 say circost[pd]
      @ r,38 say tmrcost
      @ r,52 say tpdcost[pd]
      @ r,63 say avprdcost[pd]
      r = r + 1
      pd = pd + 1
      spd = spd + interval
      if r = 24
          wait
          @ 15,1 clear to 25,74
          r = 15
      endif
ENDDO
wait
ENDPRINTJOB
@ 10,1 clear to 24,74
clear all
set status on
set talk on
set scoreboard on
return
```

```
*SUBPROGRAM FOR DATA ENTRY ON NUMBER FAILURES WITHIN A PERIOD


set status off
set talk off
set scoreboard off
PUBLIC  cost,avfailure
PUBLIC ARRAY prob[lspan]
DECLARE number[lspan],expvalue[lspan],prob[lspan]
sexpvalue = 0
period = 1
startprd = 1
DO WHILE startprd <=lspan
    @ 8,10 say "PERIOD"
    @ 8,18 say str(period)
    DO WHILE .T.
        tempnum = 0
        @ 10,10 say "ENTER NUMBER OF ITEMS THAT FAILED WITHIN THIS PERIOD"
        @ 12,10 get tempnum
        read
        @ 10,10 clear to 12,74
        @ 10,10 say "NUMBER ITEMS THAT HAVE FAILED WITHIN THIS PERIOD ="
        @ 10,58 say tempnum
        choice = space(1)
        @ 12,10 say "confirm figure if correct pess 'Y' or 'N' for correction"
        @ 12,74 get choice
        read
        @ 10,10 clear to 12,74
        if choice = "Y"
            exit
        endif
      ENDDO
      @ 8,10 clear to 8,74
      number[period] = tempnum
      prob[period] = number[period]/item
      expvalue[period] = prob[period]*period
      sexpvalue = sexpvalue + expvalue[period]
      period = period + 1
      startprd = startprd + interval
ENDDO
avfailure = item/sexpvalue
cost = avfailure * indcost
return
```

```
*SUBPROGRAM ON DATA ENTRY FOR NUMBER FAILURES UP TO PERIOD
*UNDER CONSIDERATION



set talk off
set status off
set scoreboard off
PUBLIC  cost,avfailure
PUBLIC  ARRAY prob[lspan]
DECLARE number[lspan],expvalue[lspan],prob[lspan]
sexpvalue = 0
period = 1
startprd = 1
DO WHILE startprd <= lspan
    @ 8,10 say "PERIOD"
    @ 8,18 say str(period)
    DO WHILE .T.
        tempnum = 0
        @ 10,10 say "ENTER TOTAL NUMBER OF ITEMS THAT HAVE FAILED TO DATE"
        @ 12,10 get tempnum
        read
        @ 10,10 clear to 12,74
        @ 10,10 say "TOTAL NUMBER OF ITEMS OBSERVED TO HAVE FAILED TO DATE = "
        @ 10,66 say tempnum
        choice = space(1)
        @ 12,10 say "confirm figure if correct press 'Y' or 'N' for correction"
        @ 12,74 get choice
        read
        @ 10,10 clear to 12,74
        if choice = "Y"
            exit
        endif
    ENDDO
    @ 8,10 clear to 8,74
    number[period] = tempnum
    B = period - 1
    if B > 0
       prob[period] = (number[period] - number[B])/item
     else
       prob[period] = number[period]/item
     endif
    expvalue[period] = prob[period]* period
    sexpvalue = sexpvalue + expvalue[period]
    period = period + 1
    startprd = startprd + interval
ENDDO
avfailure = item/sexpvalue
cost = avfailure * indcost
return
```

```
*SUB PROGRAM ON DATA ENTRY FOR PERCENTAGE/PROBABILITY OF
*ITEM FAILING WITHIN THE PERIOD


set talk off
set status off
set scoreboard off
PUBLIC   cost,avfailure
PUBLIC  ARRAY prob[lspan]
DECLARE ptageprd[lspan],expvalue[lspan],prob[lspan]
sexpvalue = 0
period = 1
startprd = 1
DO WHILE startprd <= lspan
    @ 8,10 say "PERIOD"
    @ 8,18 say STR(period)
    DO WHILE .T.
        temptage = 0
        @ 10,10 say "ENTER PERCENTAGE OF ITEMS THAT FAILED WITHIN THIS PERIOD"
        @ 12,10 say "NOTE multiply probability by 100 to get percentage"
        @ 14,10 get temptage
        read
        @ 10,10 clear to 14,74
        @ 10,10 say "PERCENTAGE OF ITEMS THAT FAIL WITHIN THIS PERIOD = "
        @ 10,53 say temptage
        choice = space(1)
        @ 12,10 say "confirm figure if correct press 'Y' or 'N' for correction"
        @ 12,74 get choice
        read
        @ 10,10 clear to 12,74
        if choice = "Y"
            exit
        endif
    ENDDO
    @ 8,10 clear to 8,74
    ptageprd[period] = temptage
    prob[period] = ptageprd[period]/100
    expvalue[period] = prob[period] * period
    sexpvalue = sexpvalue + expvalue[period]
    period = period + 1
    startprd = startprd + interval
ENDDO
avfailure = item/ sexpvalue
cost = avfailure * indcost
return
```

APPENDIX II

PROGRAM INPUT

Name of item :-	Illuminating bulbs
Total number of item:-	1000
Individual replacement cost:-	₦120 per bulb
Mass replacement cost:-	₦30
Life span of item:-	5 months
Interval between periods:-	1 month

Percentage of failure (cumulative)

month	1	2	3	4	5
% (cum)	10	25	50	80	1000

APPENDIX III

REPLACEMENT FIGURES

AVERAGE PERIODIC REPLACEMENT ON FAILURE ONLY = 298.51

PERIOD	REPLACEMENT ON FAILURE	CUMULATIVE REPL.	MASS REPL.
1	100	100	1000
2	160	260	1000
3	281	541	1000
4	377.10	918.10	1000
5	349.86	1267.96	1000

COSTS

AVERAGE PERIODIC REPLACEMENT ON FAILURE ONLY COST = 35820.90

PERIOD	INDIV. REPL. COST	MASS COST	TOTAL COST	AVER.PER. COST
1	12000	30,000	42,000	42,000
2	31200	30,000	61200	306000
3	64920	30,000	94920	31640
4	110172	30,000	140172	35043
5	152155.2	30,000	182155	36431.04