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A TECHNICAL SERVICES MANAGEMENT INFORMATION SYSTEM:
METHODOLOGY FOR FORECASTING AND
STRATEGY DEVELOPMENT

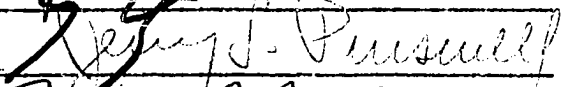
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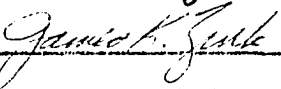
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1974

A TECHNICAL SERVICES MANAGEMENT INFORMATION SYSTEM:
METHODOLOGY FOR FORECASTING AND
STRATEGY DEVELOPMENT

APPROVED BY



DISSERTATION COMMITTEE

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A TECHNICAL SERVICES MANAGEMENT INFORMATION SYSTEM:
METHODOLOGY FOR FORECASTING AND
STRATEGY DEVELOPMENT

CHAPTER I

INTRODUCTION

Background

It has been predicted that in the 1970's an academic library would be faced with inadequate funding, new modes of organization and administration, and new roles for the library and librarians (Bolton, 1972). These predictions have already come true. Many libraries have already begun to experience financial difficulties due to insufficient institutional funding (Eaton, 1971). The financial difficulty of the library has been further aggravated by the recent cutback in the Federal Government's aid to the libraries. Thus, librarians agree that libraries are in trouble and have been for some time (Fasana, 1973).

This difficulty has been further compounded by the fact that the output of books and the other library materials has been increasing for a number of years, and will continue to increase (Raffel and Shisko, 1969; Corbin, 1973; Bowker Annual, 1960-73). In addition, the prices of books

and other library materials have not only been spiraling at a greater rate than the overall price index, but they are also expected to rise faster than the general cost of living (Booz, 1970; Raffel and Shisko, 1969; U.S. National Center for Educational Statistics, 1970; Bowker Annual, 1973).

The present and anticipated economic stress on the library is a reflection of the general financial difficulties troubling its parent system, namely the university it serves. The institution of higher education has entered into a new era which was characterized as "the new depression in higher education" by Earl Cheit (Cheit, 1971). Howard F. Bowen and Gordon K. Douglas also stated:

Since about 1955, American higher education has enjoyed an almost unworkable period of prosperity and advancement. . . . This boom has abruptly come to an end. The problem now is to meet mounting deficits and even to keep the doors open. The thoughts of college administrations are therefore turning toward retrenchment and cost cutting (Bowen and Douglas, 1972).

Consequently, the library like any other of the component parts of the university is and will be competing for limited funds.

On the other hand, there has been pressure from the faculty and students on the library management to be more immediately responsive to their needs. It is an observable fact that the rapid increase in the university curriculum, ever expanding independent study programs and research, and information explosion demand that the library acquire more materials and improve its services. In many cases, more

vocal and aggressive faculty and students, not fully aware of the library environment, are likely to register their complaints about the poor library services with the president or with the vice-president. The pressures and demands of library users will continue to increase and change as the politics, the mode of instruction, and research continue to become diverse and complicated with emphasis on both individual and team research at both the undergraduate and graduate levels. Based on this observation, Lyman predicted that the future of the libraries would be marked by more materials, more users, more services, more relationships to other agencies (Lyman, 1972).

The identification and analysis of a critical unit of the library in the context of the phenomena underscored above and the purpose of the library for which it exists is thought to be essential in defining the critical problem facing the library. Before proceeding further, it is necessary to define the purpose of the library. According to the American Council of Research Libraries, the primary purpose of a university library is to serve the reading, reference and research needs of its users (American Council of Research Libraries, 1966). Based on the purpose of a university library, the major functions of the technical services department are noted in order to view its critical relationships to the purpose of the library. The technical services department is not only charged with selecting and acquiring

useful library materials to satisfy both the present and the future information needs of the users, but it is also charged with processing the acquired materials for orderly retrieval. It has been emphasized, in view of its functions, that the success of the other units of the library depends on how well the technical services system has performed its functions (Tauber, 1953). For example, it is not possible for the public service unit of the library to retrieve the information sought by a user if such information has never been selected, acquired and processed by the technical services system. Thus, the technical services system is basically concerned with meeting the information and research needs of students and faculty by virtue of its responsibilities inasmuch as it functions as a nerve center of the entire library system on which the other units of the library depend, in discharging their service and administrative functions. Therefore, the importance of this system in terms of the purpose of the library cannot be overlooked.

Secondly, the critical nature of this department in relation to the library economy must be examined. The aggregate variable expenditure of 4,272 university and college libraries for the 1971-72 academic year alone has been reported to be \$648,788,398.00, of which \$383,229,012.00 was expended for salaries, and the remaining \$265,559,377.00 was spent for library materials (Bowker Annual, 1973). It is noted from this set of figures that 59% of the total has

been expended for personnel while 41% was used for the purchase of library materials. It has been also reported that in large libraries about 80% of total staff time is spent for acquiring and processing materials (Aslib Research Department, 1970). Since the majority of the materials as well as a major portion of the labor is consumed by the technical services department, an inference can be drawn that an overwhelming proportion of the library variable expenditure will continue to be incurred by the technical services system if the past is any indication of the future at all. Therefore this department in relation to the present and future economy of the library is critical. Since the technical service department is a critical unit of the library from the standpoint of the library's purpose and the library economy, this department is the primary focus of this research.

Based on the view that the technical services system is critically related to the purpose of the library and the library economy, the objective of the technical services department would be to select, acquire and process useful library materials¹ at the minimum possible level of cost. To accomplish this objective it is necessary first to develop a book selection model by which to select the most useful materials and acquire them at the minimum cost, and secondly to develop a processing model by which to process the acquired

¹Useful library materials in this context refer to the use of the materials by the library patrons. Measures of this use will be developed later in this study.

materials as efficiently as possible. Therefore, the needs for research in these areas are defined in the following.

Need for the Research

Academic libraries employ a combination of at least two of the three basic book selection processes which are (1) approval program, (2) faculty selection, and (3) librarian selection. The important decision of how to select materials for a library's collection, inasmuch as it affects the use and cost of library materials, requires objective information both on the use pattern and the cost associated with each of the three methods. Too often these decisions have been made in the past on the basis of intuitive estimates by librarians as pointed out by Philip M. Morse (Morse, 1968). The reason for this phenomenon is due to the fact that the library lacks objective information about the best way of providing a library service (Buckland, 1970). The need for improved library statistics for use as a tool to determine the cost and effectiveness of programs and services in relation to academic requirements has been emphasized by Booz, Allen and Hamilton in their 1970 report. In spite of all these suggestions, the selection system in current use has been practiced for many years with little discussion and little research of possible alternatives (Massmane, 1971). Furthermore, most of the academic libraries have not yet developed any methodology by which to measure the effectiveness of their selection systems. It should be noted, however,

that the quantitative standards for academic libraries (American Library Association, 1959; Clapp and Jordon, 1965; Downs, 1969; and Downs and Heusman, 1970) are available, and useful to the extent that they provide the standards to be met by academic libraries. These standards indicate the average or minimum number of volumes that an academic library should have in order to meet the informational needs of its users, but they do not provide any quantitative basis on which to assess benefits imparted to the users (Hamburg, Ramist, and Boomer, 1972). William W. Bishop emphasized that numbers of volumes meant very little in weighing the value of a library either for instruction or for research (Bishop, 1929). And again in 1957, the North Central Association of College and Secondary Schools warned that the actual number of books which a library contains is not a stable measure of the adequacy of the library (North Central Associations of Colleges and Secondary Schools, 1957). It also emphasized that more important than the total number of books in the stacks is the extent to which the selection of volumes accurately reflects the needs of the institution as defined by its educational task (North Central Association of Colleges and Secondary Schools, 1961). A well-known textbook writer maintained that to judge a collection superior or inferior on the basis of the volume holdings is as absurd as rating a college on the basis of its enrollment (Lyle, 1961). It becomes apparent then that the value of a library's

collection is primarily determined on the basis of use. A library filled with a large number of little used materials will be faced with the problems of maintaining them. As noted in the previous section of this chapter, the output of information has been increasing and is forecasted to increase even at a faster rate than ever before, but academic libraries will be faced with inadequate funding. One of the major problems facing libraries, therefore, is to uncover the best way of book selection in terms of use and cost since it appears that the best method of book selection would be one which selects those materials to be used within a reasonable time frame. However, even though the need for a qualitative measure of a library's collection has been defined and emphasized in the past, no general model for measuring the quality of the library collection has been developed.

Since any books which are purchased must be also processed, the funds required for future processing will be directly related to the book selection system. The book selection system could then be used to forecast the budget needs for the processing system. Thus, the total forecasted operating costs for book acquisition could be related to the book selection strategy chosen. The decision maker could formulate alternative strategies of book selection and test these against budgetary constraints or expectations. Going further into the book selection, budget relationship, not only is the budget a function of the book selection

strategy, but within that strategy it is also a function of the variables associated with the population of books selected, such as the probability distribution of book delivery, the cost distribution of books, the age of the books, the type and number of books and so forth. These variables, while important to the budget forecasting system, are beyond the scope of this dissertation.

Therefore, the planning of the budgetary requirements of the processing system by objective information is the prerequisite to an effective processing system. Planning in this regard must be based on the performance standard and the objective to be achieved. An effective processing system cannot be discussed in the absence of its objective and the performance standard. Even though the library profession as a whole has not developed any performance standard, there have been several studies made by academic librarians to develop such standards (Corbin, 1973; Fasana and Fall, 1967; Leornard, 1969; Smith and Schofield, 1971; and Wynar, 1963). The problem faced by the library is not the lack of performance standards, but relating these standards to the objectives of the system. The performance standards could be used directly to plan and evaluate the activities of the system relative to the achievement of its objectives. The review of the literature pointed to a need for a model through which to forecast the resource needs of the technical processing system to coordinate it with the book selection process in

order to achieve the predetermined objective of the academic library. To meet this need it is necessary to develop a model to indicate how such operational objectives of the processing system may be formulated and then to relate these objectives to the overall book selection strategy. The quantitatively defined objectives and the standards will be the basis on which the tactical plans can be developed to achieve the objectives of the technical processing system.

In view of the rapidly increasing publication output, and increasing financial pressures and the expanding information needs of users, the planning of the technical processing system through objective information is considered to be imperative for now and for the future.

Objective

Considering a model of the book selection and processing system within the technical service functions of an academic library, a management information system will be developed which could be used to monitor and evaluate book selection strategies and thereby forecast acquisition and processing costs as well as evaluate past decisions. This overall objective of the research is divided into specific objectives which are:

1. To develop a management information system which would predict the expected benefits yielded by each selection method for the forthcoming fiscal year. Such a system could be used not only to evaluate book selection strategies in an

objective manner, but it would also present an objective set of alternatives to the library management in such a way that the management could choose the best alternative in terms of benefits (see Appendix C) and cost for the forthcoming year. To develop this system, use pattern and cost data connected with each of the selection methods (a. approval plan, b. faculty selection, and c. librarian selection) were used as the basic elements of the management information system. The information on the selection cost (cost of selection and cost of material) of each selection method was developed into its unit cost by using the processing accounting technique, and the unit cost was used then to predict the expected unit cost for the forthcoming year. The information regarding the use pattern of the materials (see Appendix C) associated with each of the methods was noted by checking the circulation card of each of the sampled books, and it was used to evaluate and predict the performance of each of the selection systems. Thus, the tools used for developing the information system were those of system analysis, cost accounting, experimental design and statistical analysis. The stated objective of the research with respect to book selection was further divided into primary and secondary goals as follows.

Primary Goal:

Develop a management information model which would predict the benefits resulting from each of the selection methods for the forthcoming fiscal year at a given cost.

Secondary goals:

- a. Perform a statistical analysis to note whether or not differences in selection method affect the use pattern and cost of book selection and to evaluate the selection strategies in terms of use pattern and cost.
- b. Develop a model through which to provide the quantitative information as to which of the selection methods would be most effective in terms of recorded use for the forthcoming year.
- c. Develop a model to predict the relative effectiveness of each selection method from the standpoint of the percentage of monographs to be circulated for the forthcoming year.
- d. Provide the correlation information between the recorded use and the percentage of circulated monographs by each method.
- e. Develop a book selection costing model which would predict the cost associated with each selection system for the forthcoming year.

The data related to the secondary goals, with the exception of c., were synthesized to achieve the primary goal. The research is based on the assumption, therefore, that the effectiveness of a selection system is the function of its selection cost and benefits.

2. To develop an analytical framework which would

provide the management of a university library with a management information system for planning and evaluating the programs of its processing system. To achieve the objective the following goals were set forth for the research:

- a. Develop a processing time and cost model which would indicate the level of manpower and funds needed for processing the expected number of monographs which have been defined by the best selection system for the forthcoming year.
- b. Develop a management information system which would forecast the required level of manpower by personnel category for each activity in processing the expected number of monographs for the forthcoming year.

The data provided by this research through its methodology would be meaningful to the extent that they would aid the library administration in planning (see Appendix C for definition) its technical services system and in evaluating the system's performance. With such data: (1) the library management could choose the best selection method by comparing the benefits of the selection methods at a given input; (2) the management could prepare a realistic budget, based on the objective information, which would reflect the benefits to be derived from the budget; (3) the library could serve its users more effectively, both quantitatively and qualitatively; (4) the selection model could be used to assess the relevancy of the library's collection; (5) the

management could evaluate its technical services system by using the effectiveness measures provided by the research for both the selection system and processing system; and (6) the subsystems of the technical services system would be better coordinated and integrated through the information feedback from one subsystem to another.

To provide an insight as to how the management information system is related to the effectiveness of the system, an operational concept of a management information system (defined in Appendix C) on which this study is based follows.

A technical services system consists of two subsystems: (a) book selection, and (b) processing which are interrelated and interacting with each other, as illustrated in Figure 1. As a case in point, the planning of the processing subsystem is made in the light of the feedback from the selection subsystem, and the planning of book selection activities is controlled by the feedback from the processing subsystem. Therefore, this research considers each subsystem as an interacting part of the total system of technical services, and any efforts to improve a subsystem in isolation will not necessarily improve the performance of the total system. For this reason, it is argued that the effectiveness of the technical services system is determined not by the efficiency of any one of the subsystems, but by measuring whether or not the objective of the total system has been achieved. In order to achieve the objective, the

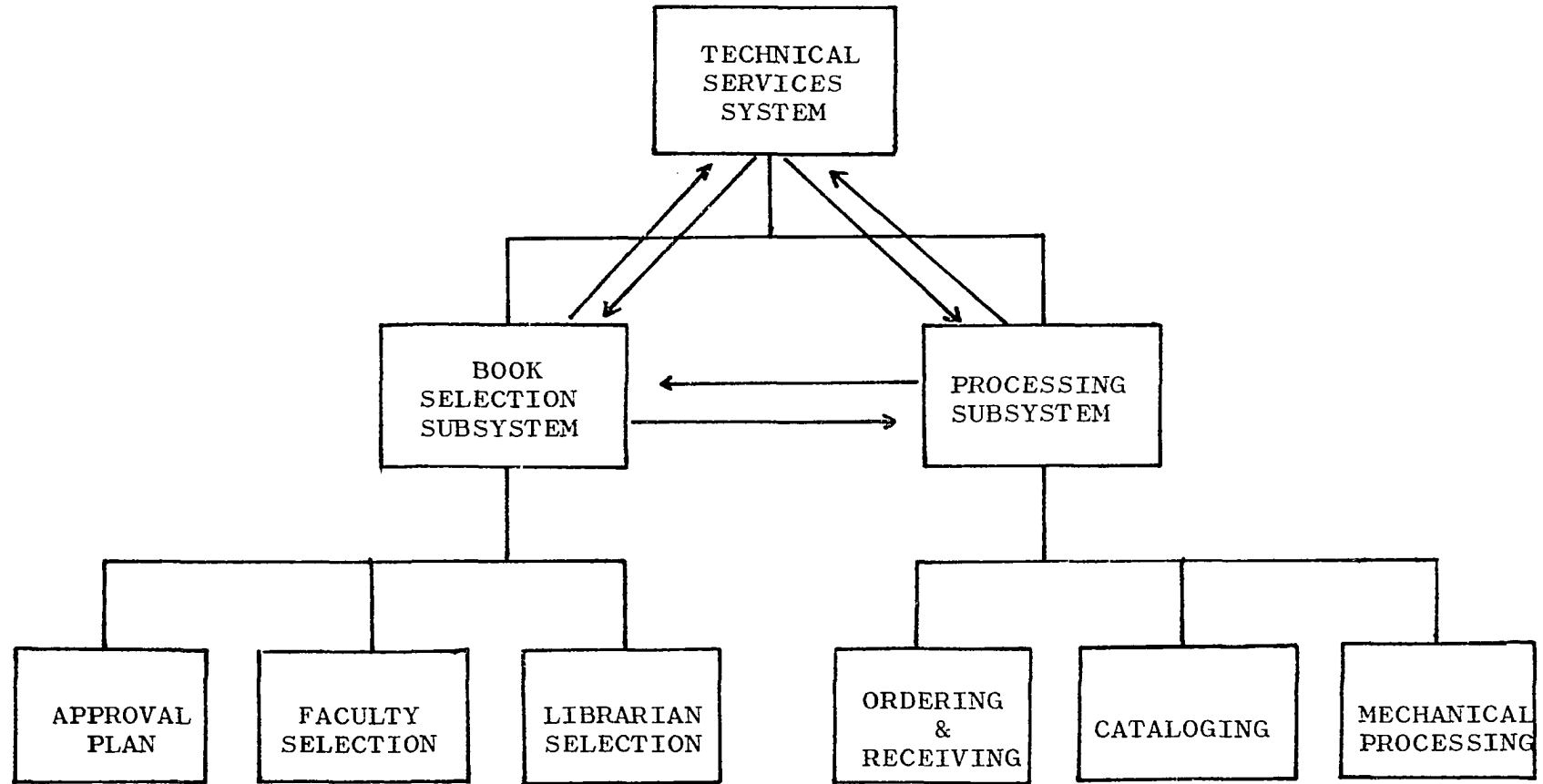


Figure 1. Structural overlay of a technical services system.

subsystems must be coordinated by an objective management information system. It is assumed that the management of each subsystem by the management information system in the context of the total system will bring about and maintain an effective technical services system. It is viewed therefore that the management of each subsystem is based on the management information provided by the other subsystem. To achieve the overall objective of this research, a management information system for each subsystem is needed not only to plan and maintain an effective subsystem, but also to provide the information necessary for the management of the other subsystem. This is the basic frame of reference for the research. Based on this research for both the selection system and processing system, the subsystems of the technical services system would be better coordinated and integrated through the information feedback from one subsystem to another.

Limitations

The research has been limited in three areas.

1. The criteria employed by the research for measuring the benefits of selection method were the recorded use, the number of circulated monographs and the number of monographs associated with the selection method in view of the fact that the recorded uses of a book were proven to be proportional to the unrecorded uses (Fussler and Simon, 1969).
2. The following types of materials were excluded

from the study: (a) standard reference titles, (b) serials, (c) gift and exchange items, (d) titles in foreign language, (e) out-of-print materials, (f) materials in microform, and (g) materials restricted to be used within the library. The research is primarily concerned with imprint English language monographs for the following reasons: (1) they are most heavily used, (2) a library allows most of the monographs to be checked out; (3) most of the libraries select this type of materials by using the combination of two or all of the selection methods, (4) they are processed in a routine manner, and (5) the selection and processing costs of such materials account for the major portion of a library's operational budget. However, the methodology could be used for the analysis of the excluded types of materials.

3. The selection model would not indicate which title to select, but it would tell in advance who and how to select the materials which will be most useful at a given cost.

CHAPTER II

RELATED RESEARCH

Effectiveness of Book Selection Method

A dissertation to determine which of the book selection methods was most effective from the use point of view was written by G. Edward Evans (Evans, 1969). Evans' dissertation was based on the following hypotheses: (1) those who have the greatest number of contacts with the library patrons would select most useful titles, (2) librarians would be more successful in selecting useful materials than either faculty members or book jobbers since they were proved to contact more patrons than any other groups of selectors, and (3) faculty members would be more successful than book jobbers. In order to test the hypotheses, the random sample of 500 titles out of the total number of titles selected under each method for each year from 1961 to 1967 was drawn and checked against the circulation record. Evans' investigation statistically confirmed the hypotheses in the predicted order that librarians had selected more titles that were used than did the faculty members or book jobbers, and faculty had selected more titles that were circulated than did book jobbers. Thus,

the study assessed the effectiveness of each selection method solely on the basis of the percentage of circulated monographs without relating it to cost. It should be pointed out that the percentage of circulated monographs would be useful to the extent that it could be used to compute the number of titles circulated. The percentage of circulated monographs itself could not be an adequate criterion in measuring the relative effectiveness of the selection methods unless the unit selection costs of all the methods were the same. Even though Evans' study produced invaluable management information with respect to book selection, it failed to establish the relationship between the benefit derived from each of the selection methods and cost associated with it. It goes without saying that the library management would need the cost and benefit data to compare and determine the best system. One of the goals of this study was to meet this very need of the library management.

Another interesting study was conducted by Philip Morse in an attempt to provide a library management with objective information about the effectiveness of the library services (Morse, 1969). The study was based on the MIT Science Library, and he developed several probabilistic models in relation to the library services. However, two of the models which were concerned with the prediction of the future use of the library seem relevant to the context

of this dissertation inasmuch as they would affect the book selection policy of the library. One of which was based on the Markov process because of its ability to relate the past and the present recorded use of the library to the future use on a timely basis. According to this, all the books of a certain class which circulated "m" times in a given year would have an average circulation $N(m)$ the next year, where the value of $N(m)$ depends solely on "m." The conditional probability that an individual book of the class with circulation "n" the next year is $T_{mn}=p(n/m)$ where

$$T_{m0} + T_{m1} + T_{m2} + T_{m3} + \dots = 1$$

$$N(m) = 0(T_{m0}) + 1(T_{m1}) + 2(T_{m2}) + 3(T_{m3}) + \dots$$

The other model developed by Morse suggested that the expected circulation (y) for a given circulation (x) could be predicted by a simple linear formula ($y = \alpha + \beta \cdot x$). He predicted that the model would be computationally more efficient than the Markov process. Thus, these models should be able to indicate the future use levels of the library books by each subject class based on the past, and thereby they would aid the management in formulating the forthcoming book selection and book withdrawal policies. Nonetheless, the application of the models would be time-consuming and costly if the library was not computerized as Morse himself stated (Morse, 1969, p. 147). It seems therefore apparent that neither the models have been tested, nor the costs associated with them have been determined.

Raffel and Shisko constructed a hypothetical book selection model which would provide alternative decision data in terms of inputs and hypothetical outputs (Raffel and Shisko, 1969). The hypothetical outputs were defined as the number of new acquisitions and the expected number of significant uses for the period of fifteen years after purchase. On the other hand, the inputs were defined as the budget for books and the budget for selection. The model would predict the various levels of outputs in relation to the corresponding levels of inputs. The model, if completed and tested, would permit a decision maker to compare the possible alternatives and to determine the best among the alternatives. Furthermore, the model would make a trade-off possible between spending money on selection and spending money on book purchasing to warrant the maximum level of the desired outputs on the part of the decision maker, as illustrated by the following table (Raffel and Shisko, 1969, p. 44).

HYPOTHETICAL OUTPUT LEVELS ASSOCIATED WITH VARYING SELECTION INPUTS

Alt.	Inputs in \$			Outputs in No.	
	Money for Books	\$ for Selection	Total	No. New Acquisition	No. of Uses
A	\$250,000	\$10,000	\$260,000	10,000	90,000
B	150,000	25,000	175,000	6,000	72,000
C	200,000	20,000	220,000	8,000	84,000
D	250,000	5,000	255,000	10,000	86,000
E	300,000	5,000	305,000	12,000	92,000
F	275,000	30,000	305,000	11,000	92,000

Raffel and Shisko's book selection model, however valuable an analytical framework it might be, did not note any method to predict the levels of significant uses from the acquired titles at the various levels of inputs. In the absence of such a method by which to determine both the expected variables of the outputs associated with each of the input variables with reasonable accuracy, it does not seem possible to put the model into use.

Another related work has been recently published in the form of journal article. In this article, a linear programming model was presented to guarantee the optimal allocation of funds to different departments of a university for purchase of books and journals (Goyal, 1973). The model was symbolized by the following formula:

$$\text{Maximize } Z = \sum_{i=1}^n C_i \cdot X_i \quad (1)$$

$$\text{where } X_i \geq L_i \quad (2)$$

$$X_i \leq U_i \quad (3)$$

$$\sum_{i=1}^n X_i = M \quad (4)$$

$$\text{and } X_i \geq 0 \quad (5)$$

$$\text{Let: } C_i = f(S_i, T_i, O_i) = \left(\frac{T_i + S_i}{2} \right) \cdot O_i$$

S_i = importance which society attaches to the work of the department.

M = the fund available for all departments.

T_i = importance which the university gives
to the work of the department.

O_i = importance due to the size of the department.

n = the number of departments, for which the
funds are to be allocated for purchase
of books.

X_i = the funds allocated for department "i."

L_i = the lower limit of funds recommended by
department "i" to the library.

U_i = the upper limit of funds recommended by
department "i" to the library.

In order to use this model, a library should design a form for all the departments to complete when submitting their estimates for purchase of books and journals. It should be divided into three categories to determine the lower and upper limits of funds: (1) books that were needed by the department to function effectively (this would be the lower limit of book funds for the department), (2) books that were desirable but not essential, and (3) books that the department would like to have if funds were available (the total of categories "1" and "2" would determine the upper limit of funds required for the department).

The author contended that most of the libraries have been faced with the problem of many unused books and journals because of their inabilities to use optimally their book funds. Librarians would therefore find the

model very useful for solving such problem according to Goyal (Goyal, 1973, p. 221). However, it would be necessary to define the values of " S_i " and " T_i " before the model could be put to use. Unfortunately, Goyal did not explain just how to determine the values of " S_i " and " T_i ." Another problem in applying this model to a library was to know M in advance, but this could not always be the case in practice.

Cost-Effectiveness Studies of Technical Services Systems

One of the Mathematical models of the technical processing systems of a university library, which is of interest to this research, has been proposed (Buckland, Hindle, Mackenzie and Woodburn, 1970). The objective of their model was to relate the input to the output on a timely basis, and it was expressed by the following equation:

For Process j ,

$$\begin{aligned} Y_j(t) &= f(0) \cdot X_j(t) + f(1) \cdot X_j(t-1) + f(2) \\ &\quad \cdot X_j(t-2) \dots \text{etc.} \\ &= \sum_{n=0}^{\infty} f(n) \cdot X_j(t-n) \end{aligned}$$

Where:

X_j represents the input rate (items per time period)

Y_j represents the output rate (items per time period)

$f(n)$ represents the fraction of books supplied during the n^{th} time period since the order was

dispatched to the book seller.

Conditions to be met:

$$P_j(t) = I_j(t) \cdot W_j(t)$$

$$Y_j(t) = P_j(t) \text{ if } B_j(t) + X_j(t) = P_j(t)$$

$$D_j(t) = B_j(t)/P_j(t)$$

where:

I_j represents the input rate (items per time period)

W_j represents the workrate (items per man-hour)

P_j represents the processing capacity (items per man-hour)

B_j represents the backlog at the end of the time period

D_j represents the delay till arrears have been cleared and next incoming item can be processed, assuming a first-come, first-processed method of working (items per time period).

Thus, the model was based on the assumptions that the output is primarily determined by the processing speed and by the number of man-hours consumed for the operation, and the work-capacity may not exceed the work-load within the processing system. The model could be used to determine the output on the basis of input on a time related basis, and it could also be used to compare the relative cost-effectiveness of a technical processing system against the other systems. Nevertheless, their assumption that the work-capacity may not exceed the work-load is not valid for now or the

foreseeable future for a majority of the academic libraries in the U.S., even though such a proposition may have been defensible in the 1960's.

An article was written by Lutz on the costing system of information services (Lutz, 1971). In his article, he first presented a theoretical basis for quantifying the benefit resulting from the information services into monetary value based on the cost associated with the services provided. And then various costing models were developed under various assumptions. The costing models should be very useful to a library manager for planning the library services in an objective way regardless of the type of library.

Cost accounting methods to determine basic unit cost which would be the bases for the budgeting and planning of a library system and for evaluating its cost-effectiveness were discussed by Brutcher, Gessford and Rixford (Brutcher, Gessford, and Rixford, 1964). A suggestion was made that the cost accounting methods might be most applicable to the technical processing system of a library, for the relationship of its input variables to its output variables is similar to an industrial processing system. The cost accounting methods could be employed to improve either the performance budgeting or the budgeting by formula (a. Clapp and Jordon, and b. the State of Washington) as many of the academic libraries have been using the performance

budgeting and the budgeting by formula. However, the cost accounting methods would be short of being efficient in evaluating and controlling the on-going operational activities of a technical processing system even though they would provide the bases on which to set up standards. Therefore, a point is made in regard to the cost accounting methods that they should be used in conjunction with other management tools for the purpose of maximizing the attainment of the overall objective of the technical services system.

Another model for the assessment of the operational efficiency of a technical services system was recommended by Helen M. Welch (Welch, 1966). Her recommendation was based on a Technical Services Cost Ratio (TSCOR). TSCOR is a ratio made up of the total cost of technical service salaries divided by the amount spent for library materials for a given year. The model relates the personnel cost of the technical services system to the cost of the library materials for a given year. This single ratio avoids the wide variation in assigning functions to different administrative units of the library, and thereby the statistical reporting system of technical services can be simplified and standardized. In addition, TSCOR may be used as a tool to assess the operational efficiency of the technical processing system from year to year, and applied to compare its relative operational efficiency among different libraries. Welch noted the TSCORs from

ten university libraries which indicated that the larger the library, the higher the ratio had been. This could be attributed to the fact that the large libraries did more original catalogings. Three of the libraries spent 81 cents to one dollar for each dollar expended for library materials. This meant that the personnel costs of the technical processing systems in some libraries were about as much as the costs of library materials. One medium-sized library with two and three million volumes had a score of 68 cents. And the remaining libraries with book collection ranging from two million volumes to half a million had TSCORs from 57 to 45 cents. The lowest was 45 cents scored by a library with 705,000 volumes. Regardless of the author's claim of the usefulness of TSCOR as a means to assess the comparative cost-effectiveness of the technical processing system, it has an inherent weakness for the reason that personnel costs are normally subjected to variation according to the economic region where the library is located, the average hourly wage and the level of the employees engaged in a given operation.

Another cost accounting model for university library operations was developed and tested by Leimkuhler and Cooper (Leimkuhler and Cooper, 1970). The primary purpose of this model was to provide university library administrators with quantitative management information needed to evaluate the effectiveness of their library programs for the preceding

year, and to plan and budget their library operations for the ensuing year. The focal point of this model is the concept of "cost center" (Leimkuhler and Cooper, 1970, p. 1) by which to collect and evaluate the cost data of each center according to its functions and responsibilities, and then to develop the standard cost of each function. To apply the concept of cost center to the technical processing system of a library, the authors viewed the system as a processing cost center consisting of two cost centers (1. acquisition cost center, and 2. cataloging cost center). The processing cost of a library is thus made up of its acquisition and cataloging costs as the cost of each of the cost centers consists of the cumulated total of the direct costs (a. cost for materials, and b. cost for labor) and indirect costs (a. overhead cost, and b. space cost) associated with each cost center. The processing cost is then divided by the number of titles processed during the preceding year to generate the standard unit cost which would be useful for a comparative evaluation purpose as well as for planning and budgeting the future library operations. The accounting model developed by Leimkuhler and Cooper to control the flow of cost through a library organization is similar to one previously expounded by Brutcher and others (see p. 33) with an exception that the former was tested with historical data from the University of California Library at Berkeley.

Barton R. Burkhalter and a team of industrial engineers made an extensive systems analysis of the University of Michigan Library in attempts to define some of the vexing problems faced by the various parts of the library, and to recommend solutions to the problems (Burkhalter, 1968). Even though this study had not gone into any specific areas of technical services as such, its contribution to library economy, insofar as accounting library labor costs is concerned, seems pervasive as it developed a basic methodology for computing the effective labor cost of a library to reflect the real cost to the library based on the concept of Engineering Economics. This model has been applied to the comparative analysis of several British university libraries by two members of the Library Management Research Unit, University Library, Cambridge, England (Smith and Schofield, 1971) to measure the administrative effectiveness of each of the libraries.

There have been several additional works dealing with the cost-effectiveness of technical processing systems (Dougherty and Heinritz, 1966; Leonard and others, 1969; Peterman, 1970; Smith and Schofield, 1971; and Wynar and others, 1963). All of the works cited were identical in methodology and nature in that they first ordered the processing activities according to their interdependent relationship, and then defined the cost of each of the activities in relation to time and productivity in attempts

to arrive at an average unit processing time and cost. In every case, some sort of diary study was employed to determine the unit processing time and cost. The contributions made by these studies to the management of academic libraries could not be overlooked, for they have been either quoted or referred by most of the library costing studies. It must be warned, however, that the performance standards defined by these studies should not be applied to other libraries unless their technical processing activities, counting and working methods were identical to those of the libraries on which such studies were based.

A dissertation was written to determine whether a computer-based or a manual technical service system was more efficient in terms of processing cost and time (Corbin, 1973). This dissertation defined the individual operations of the technical services system in a form suitable for using computer simulation techniques. However, again no explicit development of a management control system was provided.

CHAPTER III

METHODOLOGY

It has been stated that the overall objective of this research was to develop a management information system (MIS) which could be used to monitor and evaluate book selection strategies and therefore forecast acquisition and processing costs as well as evaluate past decisions. To achieve this overall objective two specific functional objectives were developed. They were:

1. to develop a book selection MIS model which would predict the expected benefits (see p. 11) yielded by each selection method for the forthcoming fiscal year at a given cost.
2. to develop a MIS for the processing system which would provide an analytical framework for the administration of a library to plan and evaluate the activities of the processing system.

One could observe, from the foregoing, the hierarchical relationship of the objective in accordance with the hierarchical level of each of the component systems in the organizational structure of the technical services system. In order for each component system to achieve its stated

objective, a framework for a management information system was developed. This management information system will be described in the following sections.

Book Selection MIS Model

It was pointed out that there are three basic selection methods which have been employed in the past and will be likely to be used in the future by most of the academic libraries in the absence of objective information as to which of the methods has been and is likely to be best in terms of use pattern and cost. The necessity of a management information system to determine the selection method or the combination of methods which would yield the best qualitative and quantitative results was also emphasized. The management information required for a decision relative to the library's objective consists of the use pattern and the cost associated with each selection method to determine the relative effectiveness of each selection method. A description of the development of this system may be found in this chapter. A summary of the procedures required to develop the management information system and implementation in a particular library may be found in the flow chart in Appendix D.

Population

The first task in developing this MIS was to determine the population to be monitored and controlled. As

mentioned previously, the population used for this study would be all the monographs in English language, other than those excluded from this study, purchased under each selection method during each of the selected past fiscal periods. For example, the monographs purchased under each selection method during each of the academic periods 1968-69, 1969-70, 1971-72, 1972-73, and 1973-74 would constitute one population. The actual selection of the population to be studied, however, would be the first thing for the library manager to do. Since it was assumed that the population to be studied would be large, it is conventional to learn about the population based on a random sample drawn from the population. However, before this could be done, the acquisition file should be examined to note whether the file is divided by the year of purchase. If not, it must be divided by the year of purchase. Once this has been done, all the monographs in English language purchased during each year should be separated, and sorted by selection method. The next step would be to arrange the monographs in selection groupings alphabetically by main entry and code each monograph in each selection grouping in a numerical order. The coding of the population must be followed by estimating the size of sample which would accurately represent the population to be studied at a set level of confidence. The sample size should be estimated on the basis of an assumed value of P (percentage of circulated

monographs within 12 months after they had been made available to the public. The value of P could be assumed either by using a librarian's experiences or by using the previous studies. In any event, this P value would be verified with the actual data.

In view of the nature and the objective of the research it can be assumed that the distribution to be studied will be binomial, in that a book either circulates or fails to circulate. Since the variate of the binomial distribution would approach the normal distribution with the increase in sample size, the following formula can be used in determining the size of sample needed to implement the book selection MIS.

$$n = P(1-P) \frac{K^2}{e^2}$$

where:

e is the range of sampling error at a given confidence level.

n is the size of the needed sample.

P is the proportion of English language monographs that were estimated to circulate once a year.

K is the value of the student-t distribution at a set alpha level.

Therefore, if one is confident that 60 percent of monographs circulate within a year after they have been added to a library collection and wants to be ± 0.05 from the true value of P (percentage of monographs) at a 0.95 level of confidence, then the sample size needed to test this

assumption would be calculated in the following manner by using the formula noted.

$$n = (0.60)(1-0.60) \frac{(1.96)^2}{(0.05)^2}$$

$$= 369$$

Since the level of confidence was set at 0.95, the value for alpha would also be 0.05 and thus the value for K would be 1.96 as found in a set of statistical tables.

Sampling Procedures and Data Collection

To insure that the samples were accurately representative of the population, a random sample should be drawn from each population by the use of a random number table. From each monograph in a randomly selected sample its author, title, date received and cost would be recorded on a book selection data collection form as illustrated in Figure 2. The next procedural step in data collection would be to identify the call number of each sampled title and record it from the card catalog. In case the title is not found in the card catalog, another title should be randomly selected from its corresponding population (see Appendix D). Each book selection data form with call number would then be checked against its book card or date due slip to record the number of times it circulated and whether or not it circulated at all within 12 months after it had been made available to the public. However, it should be noted that a library should allow the processing time based on its experiences since the books received by the library must be

Selection Method:				
Random Number:				
Author:				
Title:				
Date Received	Cost	Call Number	No. of Recorded Circulation	Whether or not Circulated

Figure 2. Book selection data collection form.

processed before they can be made available to its users. If a book is not located and cannot be traced, a new title would be randomly selected from the coded population. If a book's whose original date slip had been torn out and replaced with a new one, the average of the circulations recorded on several torn-out date due slips plus the circulations recorded on the slip in the book would be used. This would be accomplished by asking a circulation attendant to save torn-out slips and dividing the total number of the circulations by the number of the slips. The use data to be obtained from each sample would also be recorded on the book selection data collection form (Figure 2). The data reflecting the recorded uses and the number of circulated monographs associated with each of the selection methods for each period would be transformed into the mean recorded use and the percentage of circulated monographs by using a use data form such as that shown in

Figure 3. At this stage the assumed value of P would be compared with each value of the actual P 's from the collected data. If the assumed value differs greatly from the actual P , the sample size must be computed by using the actual P . In any case, if the sample size based on the assumed value is greater than the sample size based on the actual P , the former does not have to be increased.

[illegible]

Figure 3. Use data associated with each selection method for each Period.

Model for Analysis of Data on Use Pattern of Book Selection Method

An analysis would be conducted by using the two-way classification of analysis of variance procedure to learn

whether differences in book selection method or differences in time period affect the use of monographs at the chosen level of significance. By using the means recorded on the data forms, such as Figure 3, a recorded use data matrix (Figure 4) would be devised for constructing the analysis of variance table. The analysis of variance table would then be used to perform the statistical significance test. The analysis of variance is based on the assumption that differences among the means of the three samples representing the approval plan, faculty and librarian selection method can be attributed to no other causes but systematic differences in selection method, differences in time period and chance variability (Miller and Freund, 1965, p. 262).

Period Method	1	2	3	4	5	6	7	8	Average
Approval Plan	y_{11}	y_{12}	y_{13}	y_{14}	y_{15}	y_{16}	y_{17}	y_{18}	$\bar{y}_{i.}$
Faculty Selection	y_{21}	.	.	.	.	.	.	.	.
Librarian Selection	y_{31}	.	.	.	.	.	.	.	.
Average	$\bar{y}_{.j}$	.	.	.	.	.	.	.	$\bar{y}_{..}$

Note: y_{11} is the average recorded use associated with approval plan for period 1. The first subscript denotes selection method and the second subscript denotes period.
 $\bar{y}_{i.}$ is the average of i^{th} selection method
 $\bar{y}_{.j}$ is the average of j^{th} period
 $\bar{y}_{..}$ is the grand mean

Figure 4. Data matrix of recorded use prepared for statistical test and analysis.

The data (means) recorded on Figure 3 would be used to fill the blocks in Figure 4, and then the data on Figure 4 would be used to calculate the terms required for constructing the analysis of variance table. Among the terms are: total sum of squares (SST), error sum of squares (SSE), selection method sum of squares (SSm) and time period sum of squares (SSp). The terms of the squares could be defined by using the following formulas:²

$$SST = \sum_{i=1}^K \sum_{j=1}^N (y_{ij} - \bar{y}_{..})^2$$

$$SSm = \sum_{i=1}^K \sum_{j=1}^N (\bar{y}_{i.} - \bar{y}_{..})^2 = N \sum_{i=1}^K (\bar{y}_{i.} - \bar{y}_{..})^2$$

$$SSp = \sum_{i=1}^K \sum_{j=1}^N (\bar{y}_{.j} - \bar{y}_{..})^2 = K \sum_{j=1}^N (\bar{y}_{.j} - \bar{y}_{..})^2$$

$$SSE = SST - SSm - SSp$$

$$MSm = SSm / (K-1)$$

$$MSp = SSp / (N-1)$$

$$MSE = SSE / (K-1)(N-1)$$

$$F_m = \frac{MSm}{MSE}$$

$$F_p = \frac{MSp}{MSE}$$

The results obtained through the formulas would then be summarized in the analysis of variance table, because it makes the presentation of the test of statistical significance considerably easier. The analysis of variance table

²Librarians unfamiliar with the analysis of variance procedures should refer to a standard textbook on statistical experimental design.

would be used to conduct the F statistical test. The reason for performing such a test was to find out if there were a significant difference in the recorded use of monographs due to the differences in selection method or differences in time period. The level of significance should be a typical value, such as 0.05.

The Duncan multiple-range test (Miller and Freund, 1965, pp. 279-280) would be performed in order to determine the relative effectiveness of each selection method in terms of average recorded use if the test should reject the null hypothesis (H_0). On the other hand, the multiple-range test would not be performed if the test should indicate that the recorded use is not affected by selection method (cannot reject H_0). The procedures for conducting the F test pertaining to the percentage of circulated monographs and the multiple-range test to evaluate the means of the selection strategies would be the same as for the recorded use (see Appendix D).

Forecasting Model for Expected Average Use Pattern for Forthcoming Year

Expected Average Recorded Use

As noted in Chapter I, one of the secondary goals was to predict the expected average recorded use associated with each selection method for the forthcoming year. The method to be employed for forecasting the expected use would be the polynomial regression analysis as it should be

assumed that the recorded use of a book did not depend linearly on the change in time period and there was no clear indication about the functional form of the use of a monograph on the change in time period. The formula to be used to fit the data (refer to Figure 4) to polynomial by the method of least square is:

$$\sum y = nb_0 + \sum xb_1 + \sum x^2b_2$$

$$\sum xy = \sum xb_0 + \sum x^2b_1 + \sum x^3b_2$$

$$\sum x^2y = \sum x^2b_0 + \sum x^3b_1 + \sum x^4b_2$$

where:

y is the regression line value.

n is the number of period.

b is the regression coefficient.

x is the time period (time period should be scaled in a numerically ascending order from 1, 2, 3 ... where 1 denotes the first period of the study periods).

It should be pointed out that a library using the regression analysis should develop a sufficient number of data points.

"As a rule of thumb many statisticians require that the number of observations be at least five times the number of terms in the model" (Brown, 1967, p. 119). For example, the polynomial regression model for a typical library as developed in the next chapters would appear as

$$y = 1.0744 + 0.2644x + 0.025125x^2$$

Since this model has 3 terms, fifteen data points should be used in actual operation of this system.

To use the polynomial regression model, the data in Figure 4 on page 39 would be used to define the necessary terms to be substituted into the model. For example, a table to compute the required terms for the model could be developed by using the data points associated with a selection method based on an assumption that there are 8 data points, as illustrated in Figure 5. By using this

x_i	x_i^2	x_i^3	x_i^4	y_i	$x_i y_i$	$x_i^2 y_i$
1	1	1	1	y_1	y_1	y_1
2	4	8	16	y_2	$2y_2$	$4y_2$
3	9	27	81	y_3	$3y_3$	$9y_3$
4	16	64	256	y_4	$4y_4$	$16y_4$
5	25	125	625	y_5	$5y_5$	$25y_5$
6	36	216	1296	y_6	$6y_6$	$36y_6$
7	49	343	2401	y_7	$7y_7$	$49y_7$
8	64	512	4096	y_8	$8y_8$	$64y_8$
Sum 36	204	1296	8772	$\sum y_i$	$\sum x_i y_i$	$\sum x_i^2 y_i$
where: $x_i = i^{\text{th}}$ period $y_i = \text{average recorded use for } i^{\text{th}} \text{ period}$						

Figure 5. Table for determining parameters of polynomial regression analysis.

table the sums required for substitution into the model must first be computed and expressed as

$$\sum x, \sum x^2, \sum x^3, \sum x^4$$

$$\sum y, \sum xy, \sum x^2y$$

and the following system of three linear equations must be solved in three unknowns.

$$\begin{aligned} \sum y &= 8b_0 + \sum xb_1 + \sum x^2b_2 \\ \sum xy &= \sum xb_0 + \sum x^2b_1 + \sum x^3b_2 \\ \sum x^2y &= \sum x^2b_0 + \sum x^3b_1 + \sum x^4b_2 \end{aligned}$$

Through the procedures just described the regression values would be obtained. Then the statistical test to find out whether the relationship between the independent and dependent variables exists must be conducted. If the null hypothesis (no relationship between the variables ~~exists~~) ~~cannot be rejected~~, then the average of the random variables should be used for forecasting the expected recorded use, or the number of data points could be increased, if possible, and a new regression analysis should be conducted with the increased data points and the statistical significance test must be performed again. The regression value for the current period should be replaced by the actual random variable to forecast the expected average recorded use for the succeeding years since most of the academic libraries have to prepare their budget requests early in the year in order to meet the deadlines set by the university budget agencies. However, it would not be a serious problem for a majority of the libraries to update for one period. Yet, the reliability of the forecasted value for the forthcoming year will depend on the

updating of data for the current year.

The results of the analysis would then be summarized in a graphical and a tabular format. These results would not indicate the relative effectiveness of a selection method in terms of cost and benefits, but it would indicate which of the methods will be likely to be most effective in terms of average recorded use for the forthcoming year. Both the expected average recorded use and the expected unit selection cost would have to be used to predict one of the primary benefits. On the other hand, if the manager of a library regards the average recorded use as an independent benefit measure without taking into account the other benefit measures and the cost factor, he may decide to choose the selection method which will yield the highest average recorded use for the forthcoming year.

A basic assumption in this regression analysis is that for a given point in time, average use is a normally distributed random variable whose mean is the x coordinate on the regression curve at that point in time (Mize, 1971). This means that the actual average recorded use for the forthcoming year would be expected to fall within the range $\mu \pm 2$ standard deviations about 95% of the time. Thus, the standard deviation would be calculated to set up a control limit about the regression curve. The control limit would be used as a management control tool to determine whether or not a significant change in recorded usage was occurring when

actual data were recorded on the forecasted usage graph. The same procedures would be used in developing the forecast model relative to the percentage of monographs to be circulated for the forthcoming year (refer to Appendix D).

Correlation Analysis

Another secondary goal as noted in Chapter I was to provide the information as to how well the average recorded use and the average circulated monograph associated with each selection method are related. In order to provide this information a correlation coefficient for a given pair of each of the selection methods would be calculated, if a linear relationship between these variables was assumed, in the following manner.

$$r = \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}}$$

where:

r = correlation coefficient

$$S_{xx} = n(\sum x^2) - (\sum x)^2$$

$$S_{xy} = n(\sum xy) - (\sum x)(\sum y)$$

$$S_{yy} = n(\sum y^2) - (\sum y)^2$$

and

x_i = average recorded use associated with a selection method for i^{th} period

y_i = the average circulated monographs associated with the method for i^{th} period.

The use data relative to the recorded use and the percentage of circulated monographs used for performing the analysis of variance would be used for the correlation analysis. The next procedural step to be taken would be to conduct the test of significance ($H_0: \rho = 0$) in order to determine if a linear relationship between the recorded use and the percentage of circulated monographs, in fact, exists by using the following formula. The level of significance would be placed at 0.05.

$$Z = \frac{n - 3}{2} \ln \frac{1+r}{1-r}$$

where:

Z is the value of Z statistic

n is the number of the pairs of random variables

ln is the natural logarithm

r is the sample correlation coefficient

If the test cannot reject H_0 , the correlation analysis would be statistically meaningless. If H_0 is rejected, the information resulting from the analysis would be useful for formulating the general book selection policy of a library if it were used in conjunction with the information provided by the book selection model. For example, a university library director suspects that the librarian's selections may result in a higher average of use, but they may result in a poor average in terms of the percentage of circulated monographs in comparison with the other methods. A correlation analysis such as this research employed would clarify the director's suspicion. A flow chart for this procedure may be found at the end of Appendix D.

Procedures for Developing Unit Selection Cost System

The last of the secondary goals relative to the book selection MIS model would be to evaluate and forecast the unit selection cost associated with each of the selection methods for the forthcoming year. To accomplish the goal, it would be necessary to develop the procedures through which to arrive at the unit selection cost associated with each selection method.

The unit selection cost consists of the average cost of the monograph and the average cost of selection. The cost of each of the monographs in each sample was to be recorded from the acquisition file by using the book selection data collection form (see Figure 2 on page 37) to compute the average cost of the monograph by each selection method for each time period. The computation of the cost of selection attributable to each selection method would be based on the activities associated with the selection method. Therefore, the unit cost of selection assignable to each selection method for selecting a monograph for each time period would include the actual unit labor cost, unit supply cost and unit overhead cost. It should be noted that it is a usual practice for an industry and business to allocate cost of overhead when computing the unit cost of service and product. Most of the studies dealing with the cost of technical services excluded the cost of overhead from their studies (Corbin, 1973; Fasana and Fall, 1967; Leomard, 1963; Smith and

Schofield, 1971; Wynar, 1963) even through some elements of the variable overhead costs, such as the cost of administration and supervision were treated as the parts of standardizing factor. Nevertheless, the method of computing the cost of overhead has been presented in the following section since this study is concerned with developing a model for book selection cost.

The steps to be taken for developing the components of the unit cost of selection would be: (1) the identification and structuring of the activities associated with each selection method, (2) the development of the standard performance time to complete each of the activities by personnel category, and (3) the computation of the supply cost attributable to each activity. The procedures to be employed by this study in computing the unit cost of selection are presented in the following in the enumerated order.

1. The Identification of the Activities: A library planning to use this model should identify the activities associated with each selection method based on its practices. The identified activities of each selection method should be then listed in the sequential order which they are normally performed, as illustrated in Figures 7, 8, and 9.

2. Standard Performance Time for a Selection Activity: The standard performance times for most of the selection activities have been established (Corbin, 1973; Fasana and Fall, 1967; Leornard, 1969; Smith and Schofield, 1971;

Fesornick and Dehart, 1970; Voos, 1966; Wynar, 1963), and the average of these standard activity times would be used for the purpose of this study. However, a library using this model must verify these activity times by an actual time study.

3. Computation of the Actual Unit Activity Cost for a Time Period: The actual unit activity cost consists of weighted effective labor cost, supply cost and overhead cost. Each of the cost elements were computed in the following manner.

3a. Actual Labor Cost for an Activity

$$= (\text{Effective Labor Cost} + \text{Weighted Factor}^3)$$

Effective Labor Cost for the Activity

$$= (\text{Average Labor Cost per Minute})$$

$$\cdot (\text{Standard Performance Time})$$

Average Labor Cost per Minute

$$= \frac{(\text{Average Annual Salary} + \text{Fringe Benefits})}{(\text{Actual Time an Employee Spends in Library a Yr.})}$$

The actual time a librarian spends in the library per year, for example, could be computed as follows:

Paid Hours per Year	2,080
Minus	
Four Week Vacation	160
Twelve Day Sick Leave	96
Seven Holidays	<u>56</u>
Actual Hours in Library =	1,768

³Weighted factor in this context refers to the actual cost associated with a selection activity. For example, every item searched does not result in the preparation of a book order. Therefore, the unit searching cost was multiplied by a monograph searched-monograph ordered ratio to obtain the actual searching cost per monograph (Fasana and Fall, 1967).

In the case of a non-professional staff, his or her actual hours in the library would be 1,848, for typically he is entitled to two week vacation instead of four weeks. It should be noted that each library should compute the actual hours by personnel category according to its local rules and practices.

3-b. The unit supply cost would be weighted to reflect the true supply cost for the activity in the same way as for the labor cost.

3-c. The cost of overhead usually consists of the cost of utilities, depreciation of building, depreciation of equipment, insurance on equipment (Wixon, 1969) and any other allocations deemed appropriate by the library and university administration. Therefore, the overhead costs associated with the selection activities for a fiscal period should be first determined either by an actual study or by an estimate, and the total determined overhead cost should be divided by the total hours of labor spent on the selection activities for the period to obtain the overhead cost per man hour. This hourly overhead cost could be then multiplied by the unit standard time of selection to ascertain the unit overhead cost, such as that shown in Figure 6.

The costing data thus ascertained would be summarized in a tabular format by each of the selection methods for each time period (see Figures 7, 8 and 9). The unit cost of selection and unit cost of the monograph associated with each

Variable Overhead Cost:	
Indirect labor	\$xx
Utilities	\$xx
Fixed Overhead Cost:	
Depreciation of building (space)	\$xx
Depreciation of equipment (value of cost) or equipment rental cost	\$xx
Insurance on equipment	\$xx
Others	\$xx
Total Overhead Cost	\$xxxx
Total Direct Labor Hours	xxx
Overhead Cost per Manhour	\$xx
Unit Overhead Cost of Selection	\$xx

Figure 6. Unit overhead cost of selection associated with a selection method for i^{th} year.

Activity	Standard Time in Min.	Actual Labor Cost in Cents	Supply Cost in Cents
Scan Selection Media	x (P)	x	
Prepare Order Request	x (C)	x	x
Review by Acq. Libn.	x (P)	x	
Searching	x (C)	x	
Verification	x (C)	x	
Dealer and Fund Assignment	x (P)	x	
Prepare Order Form	x (C)	x	x
Distribution of Order Form	x (C)	x	
File Forms			
Total	xx	xx	xx
Summary:			
Unit Overhead Cost = x			
Unit Cost of Selection = xx			
Unit Cost of Monograph = xx			
Unit Selection Cost = xxx			

Note: (P) stands for professional librarian
(C) stands for clerical staff

Figure 7. Unit time and cost of selection by librarian selection method for i^{th} period.

Activity	Standard Time in Min.	Actual Labor Cost in Cents	Supply Cost in Cents
Order Request Card			x
Review by Acq. Libn.	x (P)	x	
Searching	x (C)	x	
Verification	x (C)	x	
Dealer and Fund Assignment	x (P)	x	
Prepare Order Form	x (C)	x	x
Distribution of Order Form	x (C)	x	
File Form	x (C)	x	
Total	xx	xx	xx
Summary:			
Unit Overhead Cost = xx			
Unit Cost of Selection = xx			
Unit Cost of Monograph = xx			
Unit Selection Cost = xx			

Figure 8. Unit time and cost of selection by faculty selection method for i^{th} year.

Activity	Standard Time in Min.	Actual Labor Cost in Cents	Supply Cost in Cents
Review by Librarian	x (P)	x	
Distribution of Form	x (C)	x	
File Form	x (C)	x	
Total	xx	xx	
Summary:			
Unit Overhead Cost = x			
Unit Cost of Selection = xx			
Unit Cost of Monograph = xx			
Unit Selection Cost = xx			

Figure 9. Unit time and cost of selection by approval program for i^{th} period.

selection method for each time period constitute the unit selection cost of the selection method for the period. Each unit selection cost would be used to prepare a data matrix for statistical analysis, such as that shown in Figure 10.

Method	Period	1	2	3	4	5	6	7	8	9	Average
Approval Plan		.	.	.	.	.	.	.	.	.	$\bar{y}_{1.}$
Faculty Selection		.	.	.	.	.	.	.	.	.	$\bar{y}_{2.}$
Librarian Selection		.	.	.	.	.	.	.	.	.	$\bar{y}_{3.}$
Average		$\bar{y}_{.1}$	$\bar{y}_{.2}$	$\bar{y}_{.3}$	$\bar{y}_{.4}$	$\bar{y}_{.5}$	$\bar{y}_{.6}$	$\bar{y}_{.7}$	$\bar{y}_{.8}$	$\bar{y}_{.9}$	$\bar{y}_{..}$

Figure 10. Book selection cost data form prepared for statistical analyses.

Analysis of Book Selection Cost Data

A F-statistical test would then be performed to learn if differences in selection method or differences in time period have a statistically significant effect on selection cost. Since there are two factors to be analyzed, the following hypotheses would be tested by placing the level of significance, say at 0.05: (1) differences in selection method do not affect selection cost ($H_0: N = 0$); and (2) differences in time period do not affect selection cost ($H_0: K = 0$). Should the test reject the null hypothesis concerning selection method, the Duncan multiple-range test would be performed to define which of the selection methods would be most economical. Even though the research with respect to book selection cost is primarily concerned with ascertaining the expected unit selection cost associated with each method for the forthcoming year and relating it to the other variables relative to use pattern in order to

provide the management of a library with the benefits connected with each selection method at a given cost, the library management would find the multiple-range test useful in evaluating the past performance of its book selection as discussed on page 41.

Model for Forecasting Expected Average
Selection Cost for Forthcoming Year

The last of the secondary goals would be accomplished by a forecast of the expected selection cost of each selection method for the forthcoming year. The examination of Bowker Annuals, 1960-73 revealed that the cost of a monograph as well as a librarian's salary has been increasing with the increase in time period. However, one is not sure that the unit selection cost associated with each selection method depends linearly on the change in time period. Initially it will be assumed that the unit book selection cost depends linearly on the time period. Based on this assumption, the linear regression analysis would be used to perform the forecasting function. The regression line value for each sample period would be calculated to draw a trend line, and the line is extrapolated into the future periods. Since the linear relationship has been assumed, it would be necessary to test the assumption by using a t statistic. If the null hypothesis (H_0 : there is no significant linear relationship of book selection cost on time period) cannot be rejected, the polynomial regression analysis would be used.

The regression analysis of book selection cost would

provide the management with a visual display of the general cost trend by each selection method. The data obtained thus far would be synthesized to achieve the primary goal with regard to book selection.

Forecasting Model of Expected Benefits by Each
Selection Method at a Given Input for
the Forthcoming Year

As noted in Chapter I, the current university library standards indicate how many volumes a university library should have, but they do not tell how many of them should be used or will be used. On the other hand the research conducted by Evans was concerned with only one of the qualitative criteria without relating it to the quantitative criterion. This study attempts to develop a methodology to synthesize both the qualitative and quantitative information about each of the book selection methods and then to develop a book selection MIS through which to determine the best way of building a useful library's collection insofar as monographs in the English language are concerned. The information to be provided by the polynomial regression analysis would indicate the relative effectiveness of each alternative for the forthcoming year in terms of use pattern, while the costing model would provide the information as to which of the selection methods would be most effective in terms of cost. The costing information and the use information could be used to note which of the alternatives would be most effective for the forthcoming year. The decision criteria by which

to compare the alternatives to choose the best alternative for the forthcoming year would be the number of recorded uses, the number of monographs to be circulated and the number of acquisitions associated with each selection method at a given budget. The benefits to be expected from each selection method at a given selection budget were obtained in the following manner:

$$EM_i = \frac{GB}{UC_i}$$

$$EU_i = (EM_i) \cdot a_i$$

$$EC_i = (EM_i) \cdot b_i$$

where:

EM_i is the expected number of monographs to be purchased under i^{th} selection method for the forthcoming year.

GB is a given budget.

UC_i is the expected average selection cost for i^{th} selection method.

EU_i is the forecasted uses associated with i^{th} selection method.

a_i is the forecasted average circulations per monograph for i^{th} selection method.

EC_i is the expected number of monographs to be circulated.

b_i is the forecasted percentage of monographs to be circulated for i^{th} selection method.

The data ascertained through the foregoing would be the critical management information to determine which of the selection methods would be most effective in terms of the benefits at a given cost. This information would then be presented in a management information matrix, a sample of which is shown in Figure 11. In case the librarian selection method was found to be superior to the other alternative methods in one primary benefit but inferior in the other benefit criterion, the management could choose either one of the alternatives or both in accordance with its priority. Thus, a decision could be made objectively rather than in a subjective manner. The book selection MIS (Figure 11) could also be used to predict the expected benefits at a certain level of acquisitions for the forthcoming year. In order for the MIS to be operational, the predicted benefits should be verified with the actual benefit measures as soon as the data are available. Consequently, the MIS could be used for planning the program of book selection as well as for evaluating the performance of a library's book selection. A flow chart portraying the procedural steps involving the book selection MIS model has been presented in Appendix D. The model developed in this chapter could be used by a library in conjunction with the flow chart.

MIS Model for Technical Processing System

The book selection MIS would indicate the best method of selecting library materials for the forthcoming year.

Selection Method	Total Book Selection Cost in \$	Expected Benefits			Forecasted Units		
		No. of Monographs	No. of Recorded Uses	No. of Mono. To Be Circulated	Unit Selection Cost	Average Recorded Use	% of Mono. Circ.
Librarian							
Faculty							
Approval							

Figure 11. Book selection MIS reporting form: expected benefits by each selection method for forthcoming year, at a given book selection cost.

Therefore, it would be logical for a library to relate this information to the processing system. To design a MIS for the processing system the number of monographs to be purchased at the expected book budget for the forthcoming year by using the best selection method would be defined. The data to be used for forecasting the expected number of monographs for the coming year would be, therefore, the expected book budget for the next year and the expected average unit cost of a monograph for the forthcoming year. The expected average unit cost associated with the best selection system would be forecasted by using an appropriate regression analysis, while the expected book budget for the forthcoming year would be estimated by the management of a library by relating the forecasted unit cost of a monograph to the number of monographs deemed necessary by the library administration for the forthcoming year. By using the procedures described the library management would be provided with the expected number of monographs to be processed and the expected book budget requirement for the forthcoming year. Without this information, the library manager would be likely to rely on intuition or experiences in planning the processing system. The planning of the system in the absence of such information might result in the waste of resources owing to an insufficient work load, or it might create a situation whereby the library would be faced with a processing backlog. This information is, therefore, necessary not only to maintain

the stability of the processing system but also to maintain the stability of the total library system. To provide management information relative to the processing system, the following data would be required: (1) unit processing time, and (2) expected unit processing cost in addition to the expected number of monographs to be processed for the forthcoming year. The procedures to be used for ascertaining these data are discussed in the following sections.

Model for Developing Unit Processing Time and Manpower Required for Forthcoming Year

A model to develop a unit processing time involves the identification of the activities required for processing a monograph and the establishment of the sequence of the activities in which they are performed. This would be accomplished by the use of a descriptive model. Either a model of a manual or computerized processing system could be used, however. Since the manual system has been proven to be more efficient than the computer-based processing system in terms of processing cost and time according to recent research findings (Corbin, 1973; Mason, 1971; Mason, 1972), this system will be illustrated for the purpose of this research. Each of the processing activities would be quantified sequentially in terms of standard performance time by using the descriptive model. The standard time for each activity is defined by personnel category so that the level of manpower needed to process a monograph by personnel

category could be defined. These data would then be related to the expected number of monographs to be processed for the forthcoming year to estimate by personnel category the level of processing manpower required for the year. The standard time for a processing activity can be obtained by averaging the published standard activity times. Finally, the number of professional and clerical staff needed could be computed and reported in a form convenient for the management to use, such as that shown in Figure 12.

Procedures for Developing Unit Processing Cost and Budget
Requirement for Processing Expected Acquisitions for
Forthcoming Year

The standard time for each activity in processing a monograph would be used to compute the expected unit labor cost.⁴ The expected labor cost is the one of the cost elements considered in computing the expected unit processing cost. The unit processing cost is composed of the expected unit labor cost, supply cost⁵ and overhead cost.

The expected unit processing cost multiplied by the expected number of acquisitions to compute the total processing cost which would be used by the management as a basis to

⁴The expected labor cost refers to the estimated labor cost for the forthcoming year. The expected labor cost would be computed by multiplying the current average labor cost by an inflation adjustment to reflect the annual labor cost increase. Each library should determine the inflation adjustment based on its own situation.

⁵Expected unit supply could be computed by using a library supply catalog which is available from a nationally known library supply company.

Category	Unit Standard Time in Min.	Unit Cost in Cents	Total Time in Min.	Needed Manpower in FTE	Needed Funds in Dollars
Professional Librarian					
Clerical Staff					
Supply					
Total					

Figure 12. MIS Reporting form indicating the level of manpower and funds required for processing the expected acquisitions (xxx) for the forthcoming year.

prepare the budget for the forthcoming year. However, the number of expected monographs should not be greater than the budgeted capacity of the processing system. This means that the book budget must be planned in such a way that the processing system with a given budget will be able to process the expected acquisitions within the defined time limit. The mathematical model used for computing the total expected processing would be:

$$\frac{B_1}{C_1} = \text{the expected number of acquisitions}$$

$$\frac{B_1}{C_1} \cdot C_2 = \text{the expected total processing cost}^6$$

subject to:

$$B_1 \leq \frac{\text{Budgeted Processing Cost}}{C_2/C_1}$$

where:

B_1 is the expected book budget for the forthcoming year.

C_1 is the expected unit cost of monograph.

C_2 is the expected unit processing cost.

Another goal set forth for the research regarding the processing system was to provide the management with the information which would indicate the number of professional librarians and clerical staff needed for each of the

⁶Expected total processing cost includes all the costs associated with the technical processing activities.

processing activities in processing the expected number of monographs for the forthcoming year. It should be noted that the allocation and scheduling of personnel by objective information are the integral parts of management planning. In order to achieve this goal, the standard time for each professional activity could be multiplied by the number of monographs to ascertain the total required professional hours for the activity, and then the total required time would be divided by the number of minutes a librarian spends in the library per year to compute the level of professional manpower needed for the activity. The level of clerical staff needed for each clerical activity would be computed in the same way as illustrated in Figure 11. The information would be useful in assigning the needed manpower to each of the processing activities to insure that the expected number of monographs would be processed within the planned time span without any bottleneck due to the misallocation of manpower. The information thus obtained would be presented on a reporting form such as that shown in Figure 13.

Finally, the expected unit cost of a monograph based on the best selection method defined by the book selection MIS model and the expected unit processing cost would be multiplied by the expected number of monographs to arrive at the total expected budget required for the technical service system for the forthcoming year. By using the flow chart showing procedural steps in developing the book

[illegible]

Figure 13. MIS reporting form indicating required manhours by personnel category for each technical service activity for forthcoming year.

selection MIS model and Appendix C (Glossary of Terms), the methodology developed by this research could be used for implementing a management information system of the technical services system of a university library. In the next chapter the use of the methodology will be demonstrated by following the procedural steps outlined in this chapter.

CHAPTER IV

APPLICATION AND DEMONSTRATION OF METHODOLOGY

The overall objective of the research was to develop a methodology to bring about and maintain an effective technical services system through a management information system. This overall objective was partitioned into two specific objectives according to the subsystems of the technical services system. In order to achieve these specific objectives, several goals were set forth for the research. The methodological procedures to accomplish the goals were presented in Chapter III. This chapter demonstrates the generality and workability of the methodological procedures.

Book Selection, Findings and Analysis

The application of the methodological procedures developed in the preceding chapter with regard to book selection was based on the data obtained from the acquisition files of the University of Oklahoma library, for this library like many other academic libraries has been using all of the book selection methods since the 1968-69 academic year, and it has kept its acquisition data in a computer printout format since the 1969-70 period. All the materials received under the Abel approval plan are listed in the printout

alphabetically by main entry according to the year of receipt. On the other hand, the materials purchased under the faculty and librarian selection methods are listed together alphabetically by main entry according to the year of receipt. The data cover the periods of 1969-70, 1970-71, 1971-72, and 1972-73. Since this research was concerned with the monographs in English language, all the monographs in the English language received under the Abel approval plan for each period were coded, as noted in the preceding chapter. In the case of the monographs in the English language purchased under the faculty selection method for each period, a red pencil was used to code each of the monographs, and the monographs acquired through the librarian selection method for the period were coded in black color. This was necessary due to the fact that the monographs purchased under the faculty and librarian selection methods were listed together in the same printout.

After the data were coded, the size of sample for each of the selection methods by each of the time periods (1969-70, 1970-71, 1971-72, 1972-73) was determined by using the formula noted in the preceding chapter based on the assumption that at least 60% of each population would have circulated within 12 months after they had been made available to the public. And also the range of sampling error was set at 0.05 at a 95% confidence level. The size of each sample was found to be 369. The estimated value of $P = 0.60$

was verified by the actual sample data (see Table 4).

By using the procedures outlined in Chapter III, the needed samples were randomly selected, and the needed data were collected. The ascertained sample data were applied to determine the relative effectiveness of each selection method in terms of benefits and cost. The analysis of the data and findings are presented in the following.

Relative Effectiveness of Book Selection Method
in Terms of Recorded Use

The data, which were collected by using the method noted in Chapter III, were used to perform an analysis of a two-way classification to learn whether difference in selection method or difference in time period affects significantly the use of monographs. To conduct such a statistical test the following data matrix was prepared (Table 1).

TABLE 1
DATA MATRIX REFLECTING THE RECORDED USE BY EACH
SELECTION METHOD FOR EACH PERIOD

Method	Period	1969-70	1970-71	1971-72	1972-73	$\bar{Y}_{i.}$
Approval Plan		1.322	1.479	1.664	1.723	1.547
Faculty Selection		1.92	2.09	1.78	1.91	1.925
Librarian Selection		1.88	1.94	2.10	1.98	1.975
$\bar{Y}_{.j}$		1.7073	1.8363	1.848	1.871	$\bar{Y}_{..}=1.816$

The data matrix was used then to prepare the analysis of variance table (Table 2) by using the formulas noted in the preceding chapter.

TABLE 2
ANALYSIS OF VARIANCE TABLE PERTAINING TO THE
RECORDED USE OF MONOGRAPHS

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F	F _{0.05}
Method	2	0.4381	0.21905	10.47	5.14
Period	3	0.04883	0.0162766	0.7782	4.76
Error	6	0.125496	0.020916		
Total	11	0.612426			

It was learned, as the analysis of variance table indicates, that differences in selection method affect the use of monographs since the value of $F_m = 10.47$ is greater than the value of $F_{.05} = 5.14$ with 2 and 6 degrees of freedom. On the other hand, it was learned that differences in time period do not affect the use of monographs according to the test due to the fact that the value of $F_p = 0.7782$ is less than the value of $F_{.05} = 4.76$ with 3 and 6 degrees of freedom. Based on this test, it was concluded that further analyses were necessary to determine which of the selection methods has been and is likely to be most effective in terms of average recorded use.

In order to determine the relative effectiveness

of each selection method in terms of average recorded use, the Duncan multiple-range test was performed by using the data in Table 1 on page 70 and the error mean square of 0.020916 in the analysis of variance on page 71. The level of statistical significance was set at 0.05. The test disclosed that the librarian and faculty selection methods are more effective than the approval program from the recorded use point of view as shown in the following table.

p	2	3
R_p	0.250	0.2596

Method	Approval	Faculty	Librarian
Mean($\bar{Y}_{i.}$)	1.547	1.925	1.975
	$1.975 - 1.547 = 0.428$		
	$1.925 - 1.547 = 0.378$		
	$1.975 - 1.925 = 0.05$		

where:

p is a measure of the distance between the two means.

R_p is the least significant range which was obtained by $s_{\bar{x}} \cdot r_p$.

$s_{\bar{y}_{i.}}$ is the estimate of $\frac{\sigma}{\sqrt{n}}$, and it was

obtained by using the formula

$$\sqrt{\frac{MSE}{n}} = \sqrt{\frac{0.020916}{4}} = 0.0723118$$

r_p is the value of multiple-range statistic at the alpha level of 0.05 (the value of r_p for $p=2$ with 6 degrees of freedom = 3.46, and r_p value

for $p=3$ with 6 degrees of freedom is 3.59). The difference between the mean associated with the librarian selected method (1.975) and the mean recorded use of the approval program (1.547), 0.428 exceeds the value of $R_3 = 0.2596$, and it was concluded therefore that the librarian selection method is significantly superior to the approval program insofar as the recorded use is concerned. The range between the means of the faculty selection method and the approval program, $1.925 - 1.547 = 0.378$, exceeds the value of $R_2 = 0.250$, and therefore the former is significantly more effective than the latter at the 0.05 level of significance. However, it was learned that there was no statistically significant difference between the librarian selection method and the faculty selection method since the difference between their means = 0.05 is less than the value of $R_2 = 0.25$.

Forecasted Value of Recorded Use for the Forthcoming
Year by Selection Method

The polynomial regression analysis was used to forecast the expected value of recorded use by each selection method for the forthcoming year by using the data in Table 2 on page 71 even though the F-test testified to the fact that there is no statistically significant relationship between

the time period and the recorded use (see Table 2 on page 71)⁷, for this research was primarily concerned with developing and demonstrating the methodology for forecasting the expected recorded use for the forthcoming year. It should be warned that any library planning to use the regression analysis should first collect a sufficient number of data points and then perform the statistical test to note whether or not relationship between the independent and dependent variables exists. It is hoped therefore that the library management continues to collect the data and develop a data bank so that reliable statistical analysis could be possible in the future.

The findings of the polynomial regression analysis are presented in Table 3 and Figures 14, 15, and 16.⁸

⁷This study, as indicated previously, was primarily concerned with developing and demonstrating the methodology for predicting the recorded use based on an assumption that a typical university library in the near future would develop a statistical data bank in which a sufficient number of data points would be stored. As a result, the use of the polynomial regression analysis was demonstrated in spite of the insufficient number of data points.

⁸The method used for computing control limit is discussed by Mize, 1971.

TABLE 3
PREDICTED VALUES FROM POLYNOMIAL REGRESSION

Method Period	Approval Program	Faculty Selection	Librarian Selection
1969-70	1.3137	1.966	1.951
1970-71	1.503	1.952	1.907
1971-72	1.6415	1.918	1.953
1972-73	1.73	1.864	2.098
1973-74	1.768	1.79	2.315
1974-75	1.756	1.70	2.631

$S_{x/y} = 0.0421473$ for the approval program
 $S_{x/y} = 0.16$ for the faculty selection method
 $S_{x/y} = 0.08$ for the librarian selection method

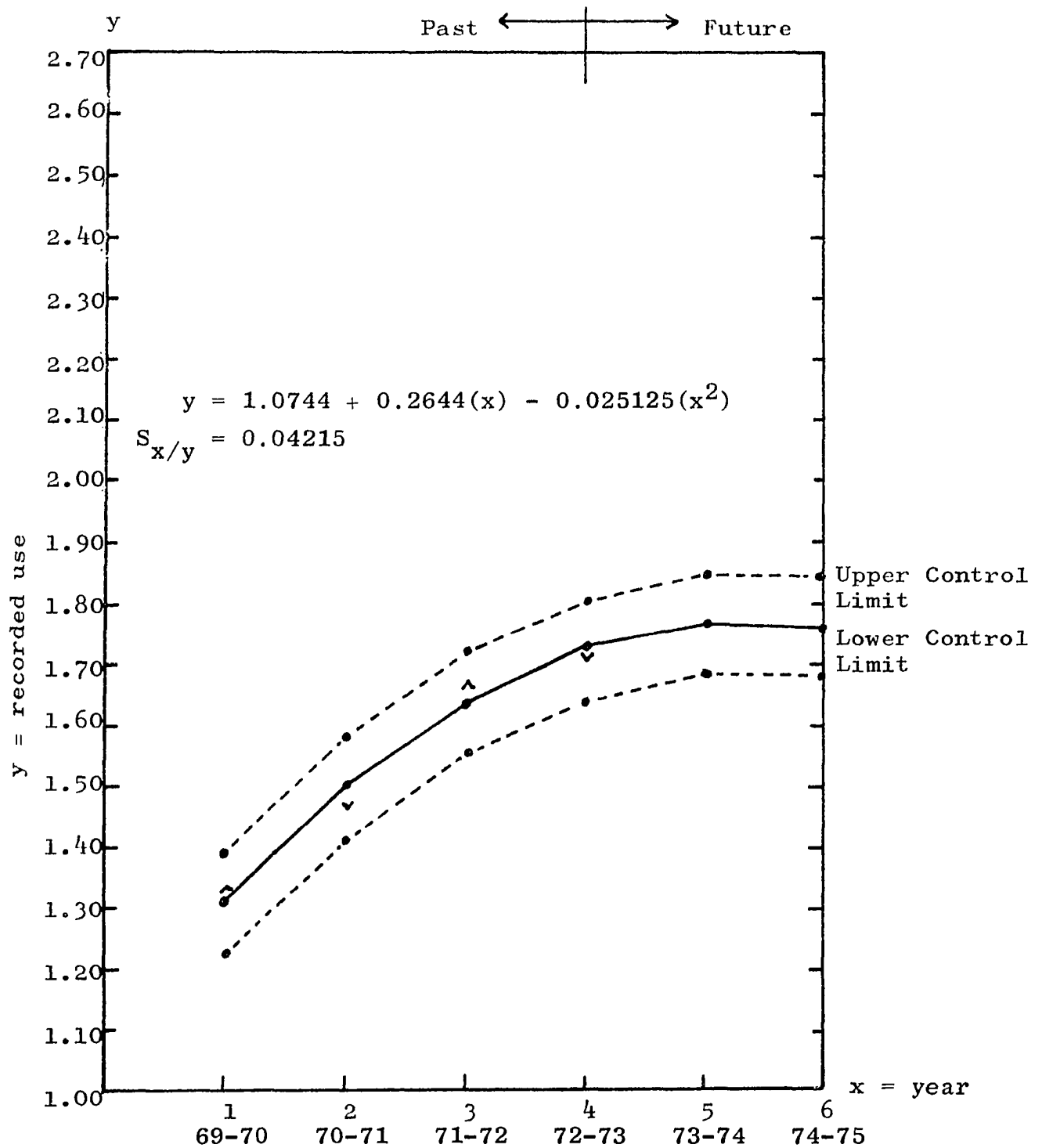


Figure 14. Polynomial Regression Analysis Forecasting Average Recorded Use Associated with Approval Plan.

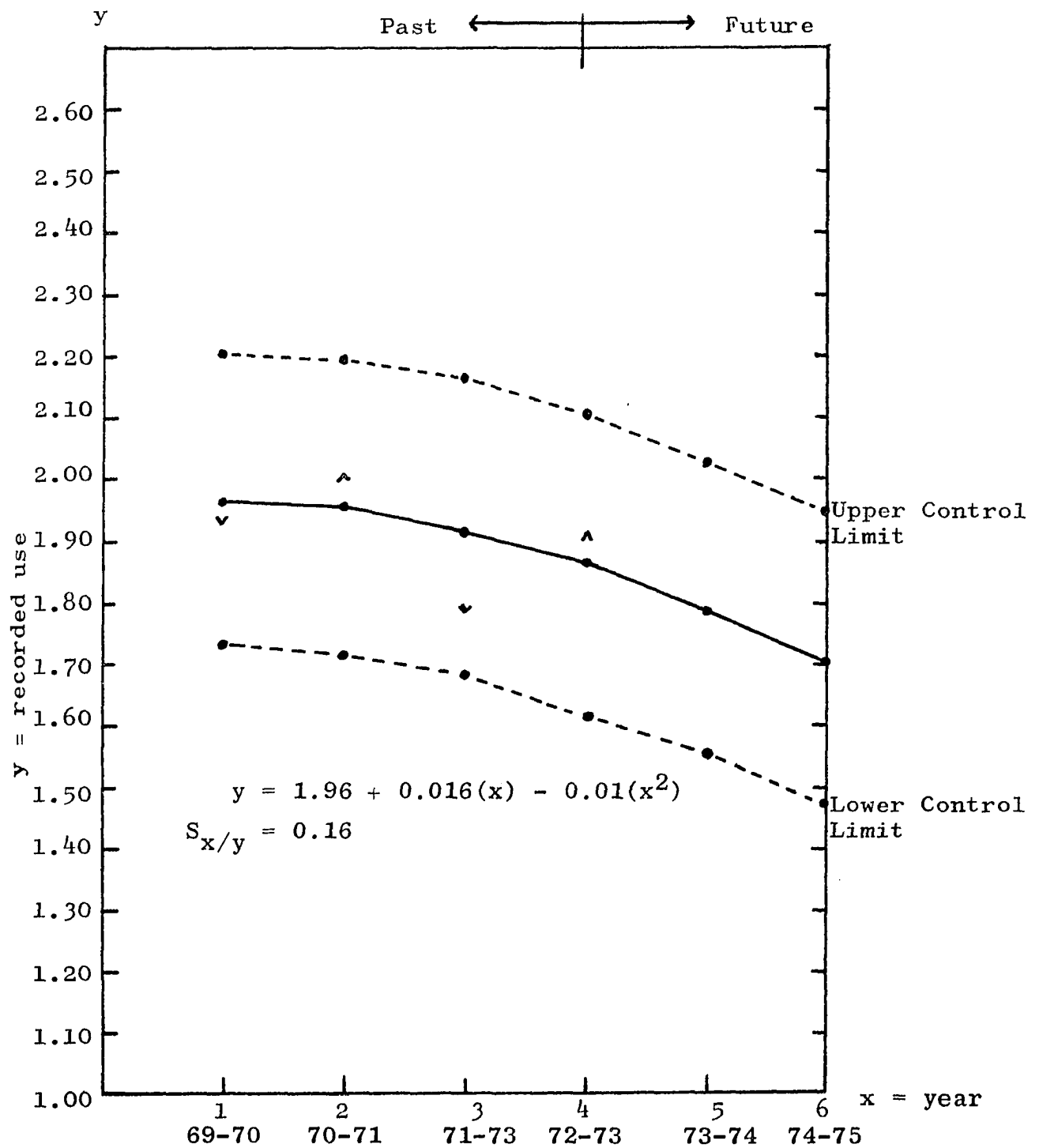


Figure 15. Polynomial Regression Analysis Forecasting the Average Recorded Use for Faculty Selection Method.

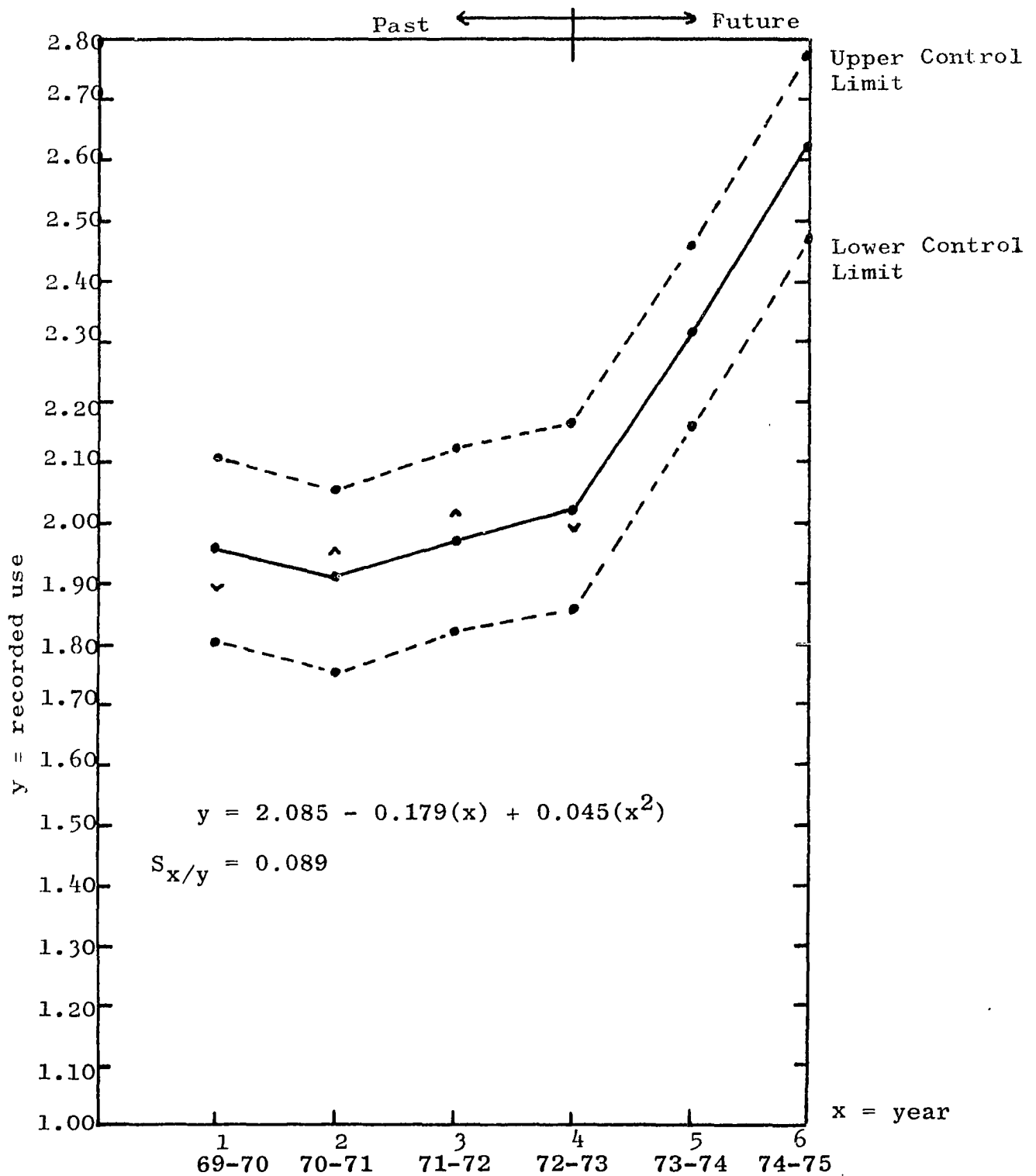


Figure 16. Polynomial Regression Analysis Forecasting the Average Recorded Use for Librarian Selection Method.

deviation of 0.089 while the forecasted values of the faculty selection and the approval program are 1.70 and 1.756, with the standard deviation of 0.16 and 0.042, respectively. An inference could be drawn that the average recorded use of a monograph under the librarian method for the forthcoming year would fall within $2.631 \pm 2(0.089)$ about 95% of the time. On the other hand, the actual recorded use of a faculty selection would be anywhere between $1.70 \pm 2(0.16)$ for 95% of the time, and the value associated with the approval program for the same period would fall within $1.756 \pm 2(0.042143)$. The forecasted value of each selection method is a necessary variable for computing one of the components of the benefit system. As noted, the regression analysis should be used only when a sufficient number of data points are available to assure the reliability of the predicted value, as noted in Chapter III.

Relative Effectiveness of Book Selection Method in Terms of the Percentage of Circulated Monographs

The F statistical test was performed to learn whether differences in selection method or differences in time period effect the percentage of circulated monographs at the 0.05 level of significance. Both the data matrix and the analysis of variance table were prepared, as illustrated in Tables 4 and 5. The test rejected the null hypothesis that there are no differences in selection method in terms of the percentage of circulated monographs since the value of F_m ,

TABLE 4

DATA MATRIX REFLECTING THE PERCENTAGE OF CIRCULATED
MONOGRAPHS BY SELECTION METHOD AND TIME PERIOD

M	P	1969-70	1970-71	1971-72	1972-73	$\bar{Y}_{i.}$
Approval Plan		0.624	0.619	0.648	0.668	0.63975
Faculty Selection		0.680	0.705	0.682	0.702	0.69175
Librarian Selection		0.710	0.694	0.734	0.729	0.71675
$\bar{Y}_{.j}$		0.67133	0.67267	0.6873	0.700	$\bar{Y}_{..}=0.6827$

TABLE 5

ANALYSIS OF VARIANCE TABLE FOR TESTING THE NULL HYPOTHESES
REGARDING BOOK SELECTION METHODS AND TIME PERIOD
PERTAINING TO THE PERCENTAGE OF
MONOGRAPHS CIRCULATED

Sources	Degrees of Freedom	Sum of Squares	Mean Squares	F	$F_{.05}$
Method	2	0.012344	0.006172	25.357	5.14
Period	3	0.0016506	0.0005502	2.26047	4.76
Error	6	0.0014609	0.0002434		
Total	11	0.0154555			

25.357, exceeds the value of $F_{0.05} = 5.145$ with 2 and 6 degrees of freedom. However, the null hypothesis that there are no differences in percentage of circulated monographs by time period could not be rejected since the value of F_p is less than the critical value of $F_{0.05}$ as noted in

Table 5. Since the test revealed that differences in selection method affect the percentage of circulated monographs, the Duncan multiple-range test was performed to determine the best selection method in terms of the percentage of circulated monographs. It was learned that through the multiple-range test the librarian and faculty selection methods averaged higher than the approval program at the 0.05 level of significance. At the same time, the range between the mean of the librarian selection and that of the faculty selection was proved to be not significant since the difference between the two methods, 0.025, is less than the value of $R_2 = 0.026979$, as shown below. Therefore, it was concluded that the faculty selection method is just as effective as the librarian selection in terms of the percentage of circulated monographs.

$\frac{p}{R_p}$	2	3
	0.026979	0.0279926

Method	Approval	Faculty	Librarian
Mean($\bar{Y}_i$)	0.63975	0.69175	0.71675
	$0.71675 - 0.63975 = 0.077$		
	$0.69175 - 0.63975 = 0.052$		
	$0.71675 - 0.69175 = 0.025$		

Expected Percentage of Monographs To Be Circulated for the Forthcoming Year, by Selection Method

The regression analysis for forecasting the expected percentage of monographs to be circulated was conducted in accordance with the procedure outlined in the preceding chapter.

The results of the test were presented in Table 6 and Figures 17, 18, and 19. The analysis indicated that the librarian selection method would be most effective for the forthcoming year since its forecasted mean is 0.78, whereas the forecasted values of the faculty and approval program are 0.694 and 0.76, respectively. However, a point should be made that the average recorded use and the percentage of monographs to be circulated do not reflect the overall effectiveness of a selection method without relating them to the cost factor associated with the method. It should be noted also that the

TABLE 6
FORECASTED PERCENTAGE OF MONOGRAPHS TO BE
CIRCULATED FOR EACH METHOD

Period	Method	Approval Plan	Faculty Selection	Librarian
1969-70		0.622	0.6845	0.705
1970-71		0.625	0.691	0.71
1971-72		0.6415	0.696	0.72
1972-73		0.670	0.697	0.73
1973-74		0.71	0.697	0.755
1974-75		0.76	0.694	0.78

$S_{x/y} = 0.0167$ for the librarian selection method

$S_{x/y} = 0.0154$ for the faculty selection method

$S_{x/y} = 0.0111$ for the approval plan

regression parameters should be updated in order to insure the accurate prediction of the average recorded use and percentage of monographs to be circulated for the periods succeeding the 1974-75 period. The standard deviation was calculated to set up a control limit about the regression curve.

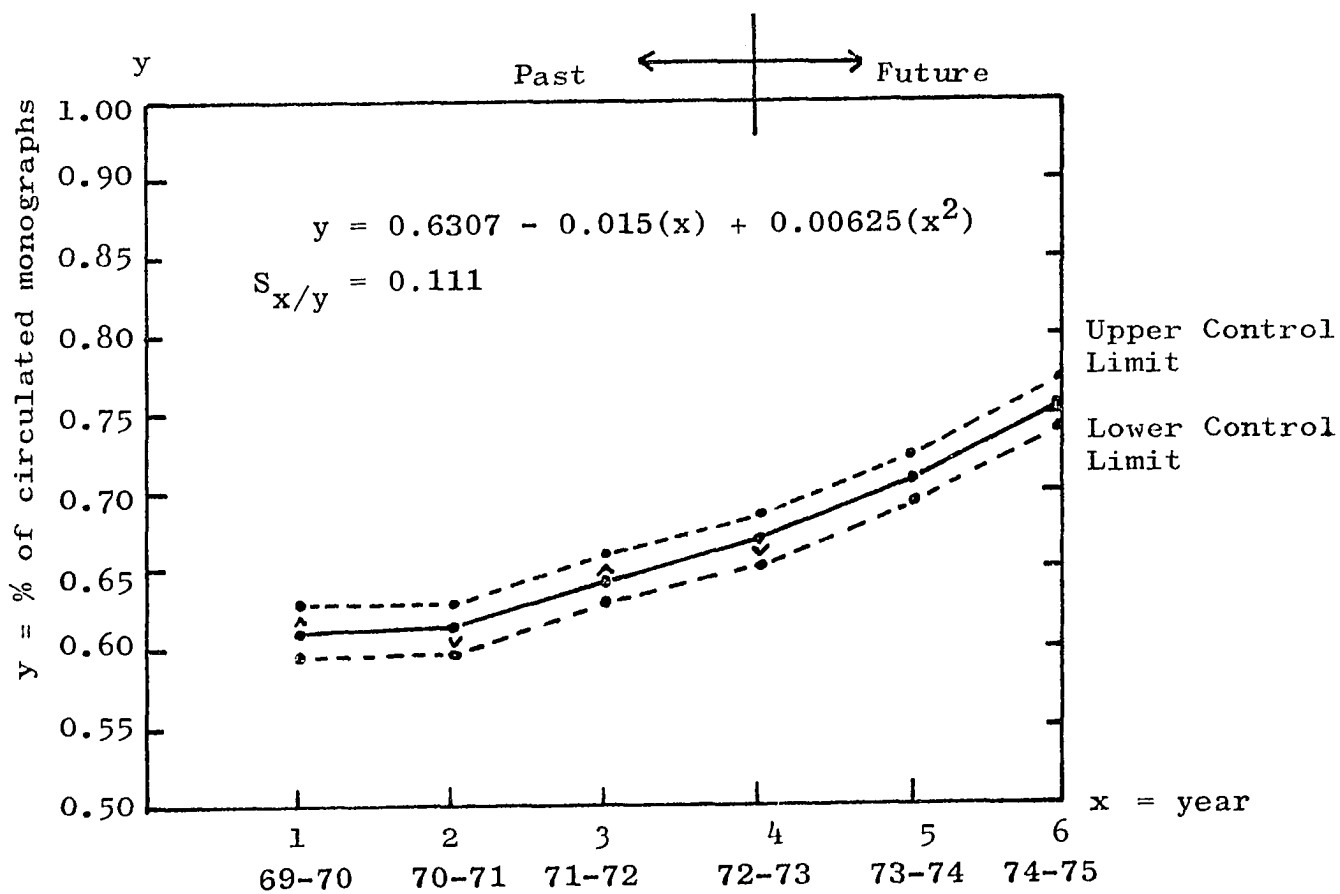


Figure 17. Regression Analysis Forecasting % of Monographs to be Circulated, by Approval Plan.

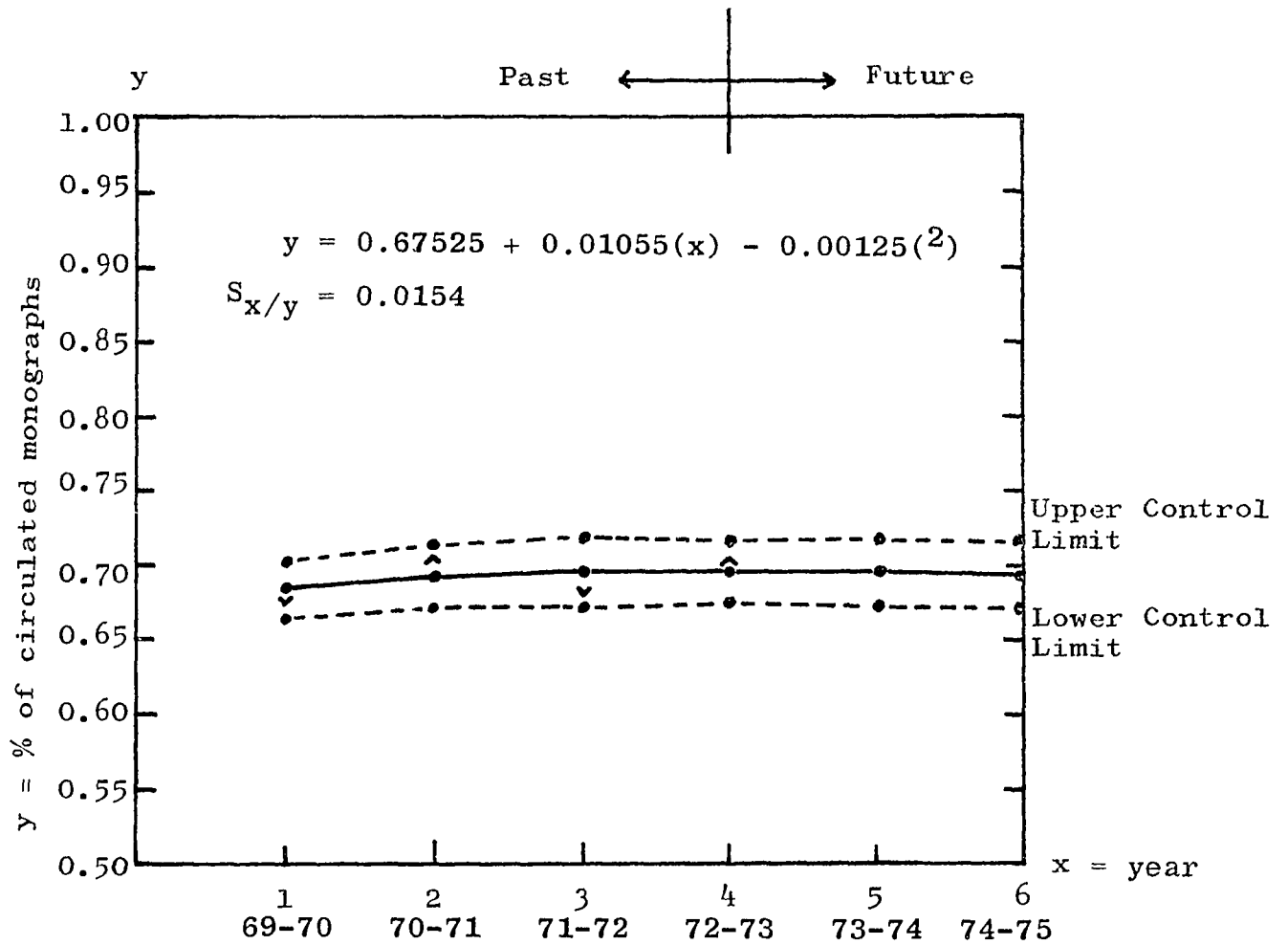


Figure 18. Regression Analysis Forecasting % of Monographs to be Circulated, by Faculty Selection Method.

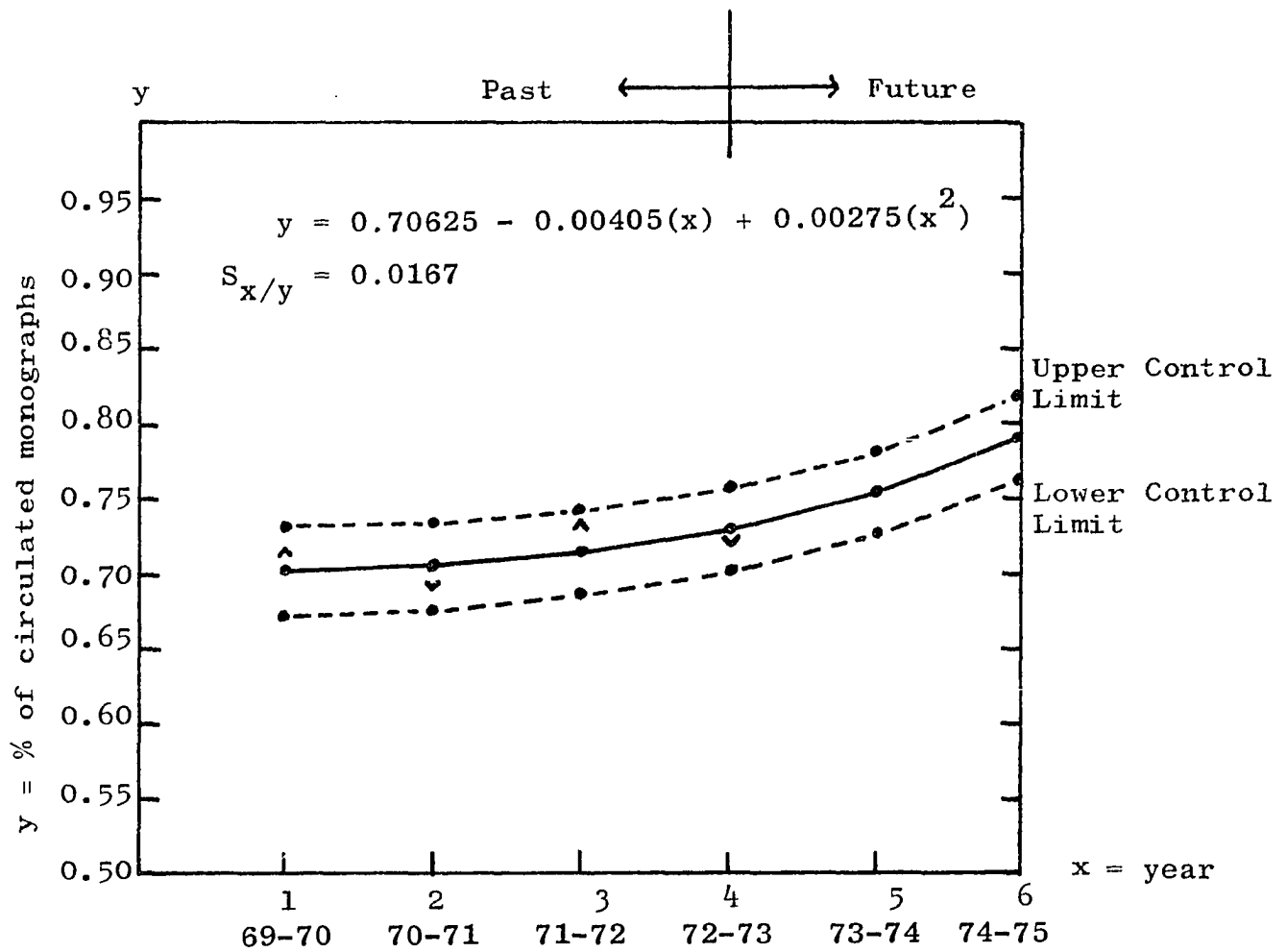


Figure 19. Regression Analysis Forecasting % of Monographs to be Circulated, by Librarian Selection Method.

One could expect, therefore, that the actual value associated with the librarian selection method for the forthcoming year would fall between $0.78 \pm 2 \cdot (0.0167)$ about 95% of the time (see Figure 19), and the actual value for the faculty selection method would be between $0.694 \pm 2 \cdot (0.0154)$. The actual random variable of the approval plan for the next year would fall within $0.76 \pm 2 \cdot (0.0111)$. The librarian should note as the actual data are recorded on the graph, if these data fall outside the control limits, that it could be an indication of a change in monograph usage, for example. The control limits have been estimated to allow for chance variation and changes beyond this range should be immediately noted. This procedure provides the librarian with a management tool which could be used to monitor system usage variations. Thus, management could recognize these variations and make earlier compensation for them, providing dynamic system control. Attention should be called to the fact that no definite pattern of the relation between the independent and dependent variables exists because of the insufficient number of random variables used for determining the regression values as in the case of the analysis of recorded use.

Correlation Analysis of Use Factors

Another secondary goal to be achieved by this study was to investigate the relationship between the percentage of circulated monographs and the average recorded use by each selection method. The information resulting from such an

analysis could be useful to the management for formulating the book selection policy of its library. For example, the management decides to evaluate the current book selection policy based on the suspected notion that the librarian book selection method results in a higher recorded use per monograph, but it performs poorly in terms of the percentage of monographs circulated at least once a year in comparison with the other methods. The correlation analysis could be used to answer the question. Unfortunately, the pairs of random variables available for this study cover only 4 periods (1969-70, 1970-71, 1971-72, 1972-73). As a result, the correlation analysis based on the four pairs of the random variables associated with each selection method was found to be statistically meaningless. It was, therefore, decided to calculate the correlation coefficient for the given pairs of the random variables representing the recorded uses and the percentages of circulated monographs associated with all the selection methods in order to learn how well the recorded use and the percentage of circulated monographs is related, and the finding was presented in Table 7. It was learned from the correlation analysis that the recorded use and the percentage of circulated monographs are highly correlated since the sample correlation coefficient is 0.94 as shown in Table 7. The next step taken in this connection was to perform the test of significance ($H_0: \rho = 0$) in order to determine if

TABLE 7

RELATIONSHIP BETWEEN THE AVERAGE RECORDED USE AND PERCENTAGE OF
CIRCULATED MONOGRAPHS

x	1.322	1.479	1.664	1.723	1.92	2.09	1.78	1.91	1.88	1.94	2.1	1.98
y	.624	.619	.648	.668	.69	.705	.68	.702	.71	.694	.734	.729

$$S_{xx} = 12(40.399122) - (21.788)^2 = 10.07252$$

$$S_{xy} = 12(15.058191) - (21.788)(8.203) = 1.97133$$

$$S_{yy} = 12(5.643827) - (8.203)^2 = 0.436715$$

$$r = 0.94$$

Note: x = random variable representing recorded use
y = random variable representing the percentage of circulated monographs
r = sample correlation coefficient

a linear relationship between the recorded use and the percentage of circulated monographs, in fact, exists by using the following formula.

$$z = \frac{n-3}{2} \ln \frac{1+r}{1-r}$$

Substituting $r = 0.94$ into the formula, the value of z was obtained.

$$\begin{aligned} z &= \frac{12-3}{2} \ln \frac{1+0.94}{1-0.94} \\ &= 5.2126 \end{aligned}$$

Since 5.2126 is greater than $z_{.005} = 2.58$ it was concluded that the sample value is significant, that there exists a linear relationship between the recorded use and the percentage of circulated monographs and since r is positive, an increase in recorded use is accompanied by an increase in % of circulated monographs.

Analysis of Selection Cost

The last of the secondary goals with respect to book selection method was to provide the information as to which of the selection methods would be economically most efficient for the forthcoming year. To meet the goal the data were collected according to the procedures outlined in Chapter III. The data were analyzed first by performing a statistical test to learn whether or not differences in selection method or in time period affect the selection cost, and then the data were used to predict the unit selection cost associated with each selection method for the forthcoming year by using the linear regression analysis. The data used for

the statistical significance test and the regression analysis were prepared in Table 8. The data in Table 8 were based on the data presented in Appendices A and B. An analysis of variance table (Table 9) was prepared by using the data in Table 8 to compute the F statistic to test the null hypotheses that neither differences in selection method nor differences in time period affect the selection cost.

TABLE 8
BOOK SELECTION COST DATA MATRIX FOR
STATISTICAL ANALYSIS

Method	1969-70	1970-71	1971-72	1972-73	$\bar{Y}_{.i}$
Librarian Selection	\$8.99	\$9.36	\$ 9.80	\$10.51	\$9.665
Faculty Selection	9.20	9.66	10.28	10.91	10.0125
Approval	8.79	9.35	10.25	11.96	10.0875
$\bar{Y}_{.j}$	8.99	9.45667	10.11	11.12167	$\bar{Y}_{..} = 9.9216$

TABLE 9
ANALYSIS OF VARIANCE TABLE FOR TESTING THE
HYPOTHESES CONCERNING BOOK SELECTION COST

Sources	Degrees of Freedom	Sum of Squares	Mean Squares	F	F .05
Selection Method	2	0.4066	0.2033	1.21409	5.14
Time Period	3	7.6977	2.5659	15.32338	4.76
Error	6	1.0047	0.16745		
Total	11	9.1091			

The null hypotheses were tested at a 0.05 significance level. The test indicated that differences in selection method do not affect the selection cost since the value of $F_m = 1.21$ is less than the value of $F_{.05} = 5.14$ with 2 and 6 degrees of freedom. On the other hand, the null hypothesis that differences in time period do not affect the selection cost was rejected as the value of $F_p = 15.3238$ exceeds the value of $F_{.05} = 4.76$. Even though the test indicated that the book selection cost is not affected significantly by selection method, separate regression equations were developed in this paper to demonstrate the methodology for predicting the selection cost associated with each selection method for the forthcoming year in order to use it for accomplishing the primary goal set forth by the research in connection with book selection.

Forecasted Unit Selection Cost by Selection Method

The data in Table 8 revealed that the book selection cost (cost of monograph and cost of selection) associated with each selection method has been steadily increasing with the increase in time period. As a result, the linear regression analysis was employed to forecast the selection cost for the forthcoming year. The regression line value for each period up to the 1972-73 period was calculated as shown in Table 10. By using the data in Table 10 the trend line was drawn, and it was extrapolated into the future up to the 1974-75 period (see Figures 20, 21, and 22). The t statistic was computed in order to determine if there was a relationship

between the time period and the book selection cost associated with each selection method. Based on the result of the test, the null hypothesis was rejected at the 0.05 level of significance in every case.

TABLE 10
FORECASTED SELECTION COST BY SELECTION METHOD

Method	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75
Librarian	\$8.915	\$9.145	\$9.915	\$10.415	\$10.915	\$11.41
Faculty	9.15	9.725	10.30	10.87	11.45	12.03
Approval	8.526	9.567	10.608	11.649	12.69	13.73

It was learned from the regression analysis that the librarian book selection method would be most economical for the forthcoming year in view of the fact that its predicted cost is \$11.41 compared with \$12.03 and \$13.73 to be incurred by the faculty selection method and approval program. By relating the standard deviation to the forecasted unit selection cost connected with the librarian selection method for the forthcoming year, one could expect that the actual unit selection cost by the librarian method will fall within $\$11.41 \pm 2 \cdot (0.1243)$ for 95% of the time. On the other hand, the actual unit selection cost of the faculty method will be anywhere between $\$12.03 \pm 2 \cdot (0.06414)$, and the unit cost of the approval program will fall within $\$13.73 \pm 2 \cdot (0.4133)$.

It should be noted that the random variable for the

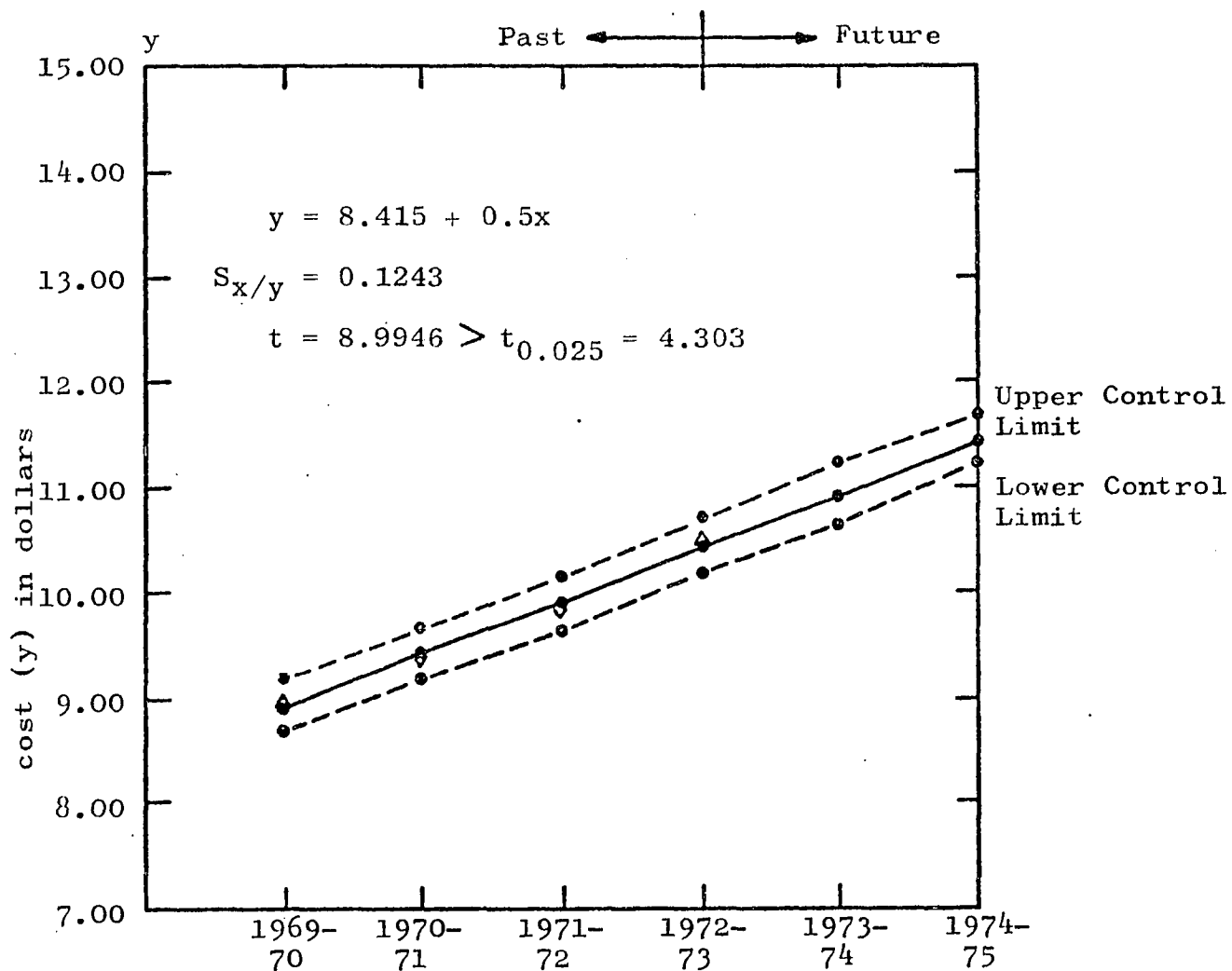


Figure 20. Regression Line Values for Unit Book Selection Cost Associated with Librarian Selection Method.

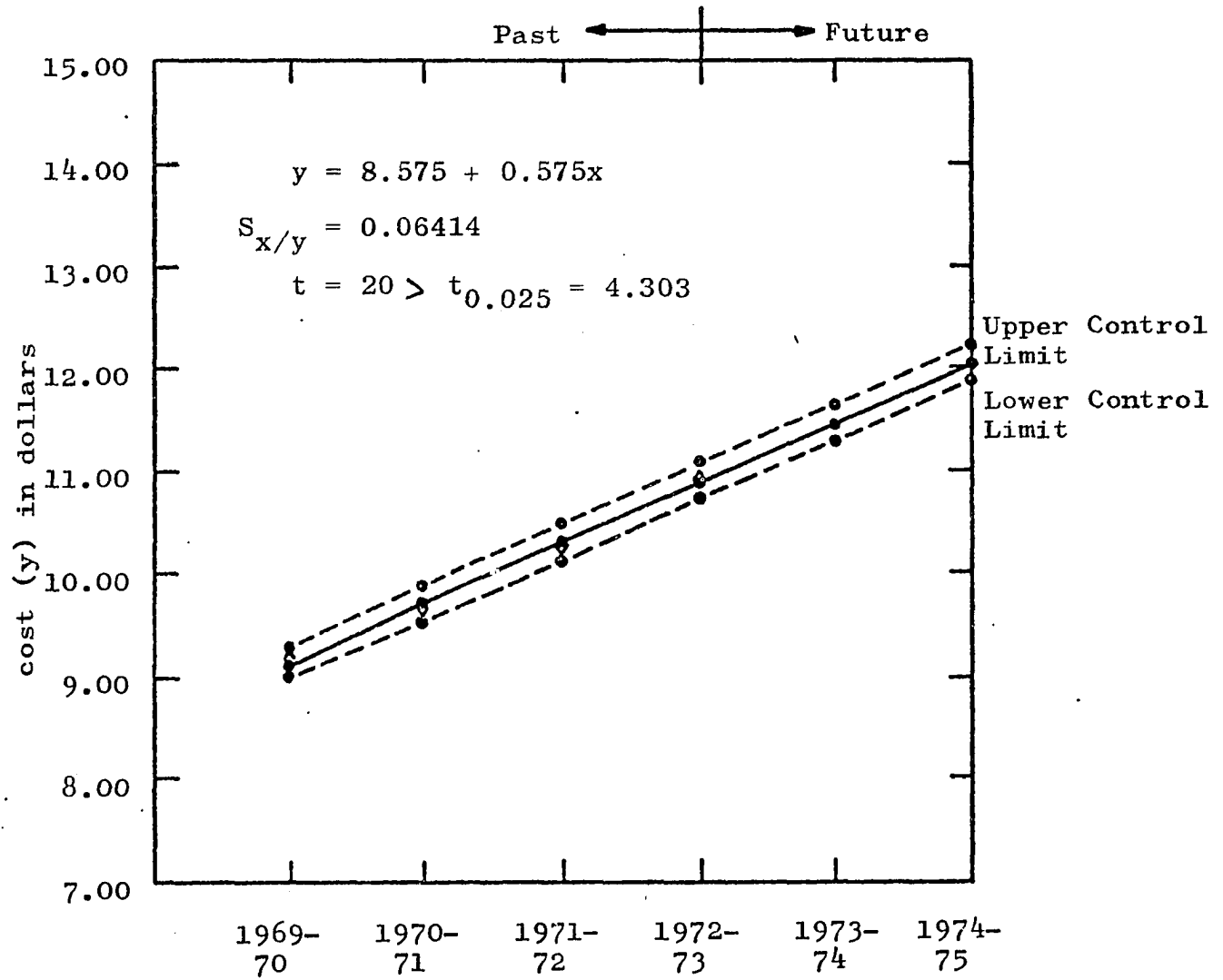


Figure 21. Regression Analysis of Unit Book Selection Cost of Faculty Selection Method.

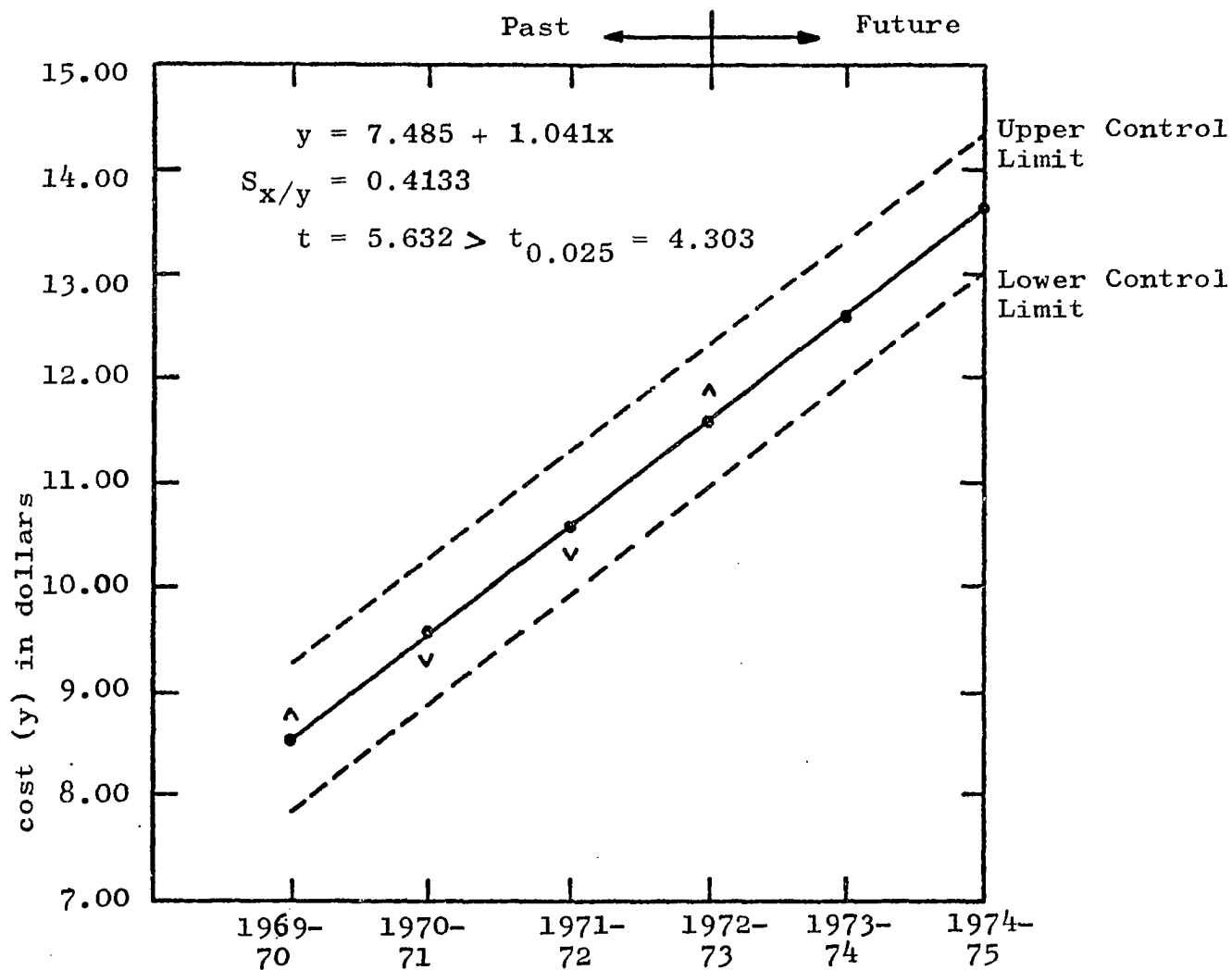


Figure 22. Regression Analysis of Unit Book Selection Cost of Approval Program.

1973-74 period should replace the forecasted value as soon as the data become available in order to forecast the unit selection cost of the selection method for 1975-76. The forecasted unit selection cost of each selection method will be related to its expected recorded use and percentage of monographs to be circulated in order to define the expected benefits which are the primary goal of this research in connection with book selection.

Benefits Associated with Each Selection Method at a Given Input

The primary goal of the research concerning book selection was to provide the management of the library with objective information which would indicate the benefits to result from each selection method for the forthcoming year at a given cost. The information developed in the preceding section of this chapter provided the necessary data to achieve the primary goal. It was noted also that the data were synthesized to achieve the goal instead of taking each data point in isolation from the other data points. Therefore, the data are the necessary variables for developing the management decision matrix by which to determine the best selection method, as shown in Table 11. According to the information provided by Table 11, the librarian selection method would be superior to the other method in all three benefit criteria. The matrix also revealed that the faculty selection method will be better in every benefit

TABLE 11

MANAGEMENT DECISION MATRIX: EXPECTED BENEFITS ASSOCIATED WITH EACH
SELECTION METHOD FOR 1974-75, AT A GIVEN COST

Selection Method	Total Budget for Book Selection in \$	Benefits			Forecasted Unit		
		No. of Mono- graphs	No. of Recorded Use	No. of Mono. Circulated	Unit Selection Cost	Average Recorded Use	% of Mono. Circ.
Librarian	200,000	17,528	46,116	13,672	11.41	2.631	0.78
Faculty	200,000	16,625	28,263	11,538	12.03	1.70	0.694
Approval	200,000	14,567	25,580	11,071	13.73	1.756	0.76

Note: Forecasted unit selection costs have been presented in Table 10.
Forecasted average recorded use and percentage of monographs to be circulated have been presented in Tables 3 and 6, respectively.
Total budget for book selection is composed of the total cost of monographs and the total cost of selection.

criterion than the approval program for the forthcoming year in spite of its smaller average recorded use and the smaller percentage of monographs to be circulated than those of the approval program. The reason for this is that the unit selection cost together with the given budget determines the number of monographs to be purchased, and the number of monographs together with the average recorded use and the percentage of monographs to be circulated determine the primary benefits for the forthcoming year. The information in Table 11 would enable the library management to compare the alternatives and to choose the one which would yield the best results. If the library should use two of the alternatives for political or any other reasons, it could choose the best two and adjust its staff requirements accordingly. Furthermore, the information would aid the management in developing tactical plans for its processing system, for it indicates in advance the number of monographs to be processed by the processing system.

Demonstrating the Methodology with Respect to Processing System

The objective of the research with regard to the processing system was to provide the management of a university library with an objective management information system for planning and evaluating the activities of its processing system. The objective was divided into two goals. They were: (1) to develop a processing time and cost

models which would indicate the level of manpower and funds needed for processing the expected number of monographs; and (2) to develop a management information matrix which would indicate by personnel category the level of manpower required for each activity in processing the expected number of monographs for the forthcoming year. The procedures employed to achieve the goals were outlined in Chapter III.

Level of Manpower and Funds Needed for Processing the
Expected Acquisitions for the Forthcoming Year

The management decision matrix (Table 11) regarding book selection confirmed that the librarian selection method is the most effective way of building the library collections in terms of cost and use pattern for the library chosen by this study for the purpose of demonstrating the methodology relative to selection. Based on this information, it is assumed that the library management would decide to acquire monographs in English language through the librarian selection method.

To achieve the first goal the expected number of monographs to be processed for the forthcoming year, the unit processing time and cost were defined in accordance with the procedures outlined in the preceding chapter. However, the computation of the expected acquisitions requires the unit cost of monograph and the expected book budget, as noted in Chapter III. The expected cost of monograph for the forthcoming year was obtained by the linear regression analysis

based on the sample data noted in Appendices B:1-B:4 and presented in the following table (Table 12). It was learned from Table 12 that the expected unit cost of a monograph associated with the librarian selection method would be \$9.52 for the forthcoming year. The unit cost was then related to the expected book budget (assuming \$166,866.56) in order to ascertain the expected number of acquisitions (17,528). The expected number of acquisitions has now been defined. The next step is to define the unit processing cost to achieve the goal.

As illustrated in Figure 1 on page 15, a technical services system defined by this study is composed of two subsystems (a. book selection subsystem, and b. processing subsystem). The component systems of the processing subsystem are ordering and receiving, the cataloging and mechanical processing. Each component system consists of a number of activities. For the purpose of constructing the matrix table used for reporting the unit activity time and cost,

TABLE 12
EXPECTED UNIT COST OF MONOGRAPH UNDER
LIBRARIAN SELECTION METHOD

1969-70	1970-71	1971-72	1972-73	1973-74	1974-75
\$8.037	8.334	8.63	8.928	9.225	9.52

Note: $y = 7.74 + 0.297 x$
 $S_{x/y} = 0.111$
 $t = 5.983 \geq t_{0.025} = 4.303$

the selection, ordering and receiving activities, and their times and costs are presented in a single table as shown in Table 13. The matrices reflecting the cataloging and mechanical processing activities were presented in Table 14 and 15, respectively. The work activities listed in these tables were defined in Appendix C; and the cost for each activity was computed by using the data in Appendices A and C with the framework of the procedures outlined in Chapter III. The standard time for an activity was estimated by averaging the published standard activity times (see p. 50). As noted, the primary concern of this study was to develop a model which would indicate the expected level of manpower and cost by each of the categories necessary for processing the expected number of monographic acquisitions for the forthcoming year. By using the data in Tables 13, 14 and 15, the expected level of manpower and cost required for processing 17,528 monographs were categorically computed and reported to the library management in a matrix format as shown in Table 16. The information provided in Table 16 revealed that the technical services system of the library would need 3.55 professional librarians and 9.4 supporting staff to process 17,528 monographs for the forthcoming year. The total processing cost covering personnel, supply and overhead would be \$108,348.80. This information would be necessary and useful to the library management for carrying out its management functions. Another goal to be achieved

TABLE 13

ACTUAL UNIT STANDARD TIMES AND COST FOR SELECTION,
ORDERING AND RECEIVING ACTIVITIES FOR FORTHCOMING
YEAR, BY LIBRARIAN SELECTION METHOD

Work Activities	Stan- dard Time, in Minutes	Actual Labor Cost in Cents	Supply Cost in Cents (Weighted)	Overhead Cost in Cents*
Scan Selection Media	1.38 (P) (1.2)	15.77		
Prepare Order Request	2.53 (P) (2.2)	14.34	1.03	
Review by Acq. Librarian	.149 (P) (.13)	1.71		
Searching	1.32 (C) (1.2)	7.48		
Verification	7.35(C) (7.00)	41.67		
Dealer & Fund Assignment	.536 (P) (.51)	6.126		
Prepare Order Form	5.397 (C) (5.14)	30.60	1.5	
Distribution of Order Form	1.365 (C) (1.3)	7.74		
File Order Form	2.31 (C) (2.2)	13.10		
Receiving Rou- tines	4.2 (C)	23.82		
Invoice Rou- tines	2.51 (C)	14.23		
Claim of Over- due Book	.43 (C)	2.44		
Accounting Routine	1.53 (C)	8.69		

TABLE 13 (Continued)

Work Activities	Standard Time, in Minutes	Actual Labor Cost in Cents	Supply Cost in Cents (Weighted)	Overhead Cost in Cents
Accessioning	1.76 (C)	10.02		
Subtotal	31.31	197.74	2.53	9.9

*Hourly Overhead Rate was assumed to be 19 cents.

Note: It is assumed that 5% of the librarian selections are rejected by the acquisition librarian, 5% of the approved items are returned to requestors during the process of searching and another 5% of the ordered items are cancelled. These factors were weighted and added to the unit activity time and cost whenever applicable. For example, the actual unit scanning cost is 15.77 cents even though the unit labor cost is only 13.716 cents, for the unit scanning cost must be adjusted by multiplying the unit scanning cost by the weighting factor to reflect the actual unit scanning cost ($13.716 \times 1.15 = 15.77$). Each library should determine the weighting factor by conducting the actual study.

TABLE 14

EXPECTED UNIT CATALOGING TIME AND COST

Work Activities	Standard Time in Min.	Labor Cost	Supply Cost	Overhead Cost*
Searching	3.01 (C)	17.07		
Cataloging	14.74 (P)	169.05		
Check in Shelf List	2.43 (P)	27.77		
Card Production in a Set of 6	4.72 (C)	26.74	3.71	
Typing Cards	3.97 (C)	25.75		
Typing Book Pockets	0.93 (C)	5.27	0.695	
Typing Book Cards	0.93 (C)	5.27	0.300	
Shelflisting	2.06 (C)	14.51		
Card Inspection	1.87 (P)	21.37		
Filing a Set of Cards	6.05 (C) 0.567(P)	34.30 6.48		
Total	42.385	353.58	4.705	17.66

Note: It is assumed that only 5% of the monographs in English language are originally cataloged. The standard time for cataloging an item with L.C. proofslip is 14.12 minutes and the original cataloging time is 27.53 minutes.

*Hourly overhead rate for cataloging department was assumed to be 25 cents.

TABLE 15

UNIT STANDARD TIME AND COST ASSOCIATED WITH EACH
OF THE PHYSICAL PROCESSING ACTIVITIES

Work Activities	Standard Time in Min.	Labor Cost	Supply Cost	Overhead Cost*
Book Spine Label- ing	1.3 (C)	7.371	0.3	
Sorting of Pro- cessing Mater- ials	2.73(C)	15.48		
Pasting Operation	.71(C)	4.626	0.6	
Property Stamping	.25(C)	1.42		
Review	.43(C)	2.44		
Total	5.42	30.73	0.9	1.53

Note: Hourly overhead rate was assumed to be 17 cents.

by the research was to provide the management with the information indicating the level of manpower needed to perform each of the activities for selecting and processing the expected number of monographs for the forthcoming year. This information would be needed by the management to allocate the right kind and amount of human resources to each of the technical service activities for processing the anticipated number of monographs.

TABLE 16

THE LEVEL OF MANPOWER AND FUNDS REQUIRED FOR PROCESSING THE
EXPECTED ACQUISITIONS (17,528) FOR THE
FORTHCOMING YEAR

Category	Unit Standard Time, in min.	Unit Cost, in Cents	Total Time in Min.	Needed Manpower in FTE	Needed Funds in Dollars
Professional Librarian	21.497	245.71	376,799.41	3.55	43,068.17
Clerical Staff	59.07	334.955	1,035,466.6	9.40	58,710.96
Supply		8.135			1,425.90
Overhead		29.346			5,143.77
Total	80.567	618.146	1,412,266.	12.95	108,348.80

- Note: 1) Number of expected acquisitions for forthcoming year = 17,528
Effective Average Salary of professional librarian for 1974-75 = \$12,124.68
Actual hours a librarian spends in the library = 1,768
Librarian's hourly wage = 6.86 (wage rate by minute = 11.43)
- 2) Effective average salary of non-professional staff for 1974-75 = \$6,386.96
Actual hours spent by a non-professional staff = 1,848
Non-professional hourly wage = \$3.40 (wage rate by minute = 5.67).
- 3) $\$166,866.50 \leq \frac{108,348.80}{6.18/9.52}$: $\$166,866.50 \leq \$166,906.25$ the condition laid down in P. 64 is satisfied.

Allocation of Manpower to Each of the Technical Service Activities

As indicated in the preceding, the goal was to provide the management with the information on the level of manpower needed to perform each technical service activity. Some of the activities require professional training, skill and judgment, while the others require clerical training and skill. It is essential for the management, therefore, to see to it that its professional staff would not waste their professional skills on clerical activities. The variables needed to achieve the goal were: (1) forecasted number of monographs, and (2) unit activity time by personnel category. The needed variables have been already defined in the preceding section of this chapter. By relating each of the unit activity times to the number of monographs, the man hours needed for each activity for the forthcoming year were computed by personnel category and reported in such a format that the information could be not only useful in terms of the management goal but also readily usable from the manager's point of view, as shown in Table 19. The information in the table tells the management how many man hours to be assigned to each activity by personnel category. For example, it indicates that the management should assign 403.14 professional hours to the book selection scanning activity for the forthcoming year to select 17,528 monographs in the English language.

TABLE 17

REQUIRED MAN HOURS BY PERSONNEL CATEGORY FOR EACH TECHNICAL
SERVICE ACTIVITY FOR FORTHCOMING YEAR

Activity	Unit Activity Time in min.	Professional Time in Hours	Clerical Time in Hours
Scan Selection Media	1.38	403.144	
Prepare Order Request	2.53		739.097
Review by Acq. Libn.	.149	43.528	
Searching	1.32		385.616
Verification	7.35		2,147.18
Dealer & Funds Assignment	.536	156.58	
Prepare Book Order Form	5.397		1,576.64
Distribution of Order Form	1.365		398.76
File Order Form	2.31		674.828
Receiving Routine	4.2		1,226.96
Invoice Routine	2.51		733.25
Claim on Overdue Book	.43		125.62
Accounting Routine	1.53		446.96
Accessioning	1.76		514.155
Searching for Cataloging	3.01		879.32
Cataloging	14.79	4,320.652	
Check In Shelf List	2.43	709.884	
Card Production	4.72		1,378.8693
Typing Cards	3.97		1,159.7693
Typing Book Pocket	0.93		271.684
Typing Book Card	0.93		271.684

TABLE 17--Continued

Activity	Unit Activity Time	Professional Time in Hours	Clerical Time in Hours
Shelflisting	2.06		601.79466
Card Inspection	1.87	546.2893	
Filing Cards	6.05(c) 0.567(p)	165.6496	1767.4066
Book Spine Labelling	1.3		379.7733
Sorting of Processing Materials	2.73		797.524
Pasting Operation	.71		207.4146
Property Stamping	.25		73.0333
Review	.43	125.617	

Note: Number of monographs to be selected and processed
= 17,528.

To implement the final phase of the MIS of the technical services system the total expected budget required by the system was forecasted by using the best selection strategy. As reported in Table 12, the expected average cost of monograph to be purchased under the librarian selection method for the forthcoming year would be \$9.52. This average cost could be related to the expected number of acquisitions to obtain the required book budget for the next year. The expected number of acquisitions should be defined by the library management based on the needs and historical acquisition data of the library. For example, if the management defines the expected acquisitions to be 17,528 monographs for the forthcoming year, then required budget for the year would be $\$9.52 \times 17,525 = \$166,838.00$. The expected book budget could be applied to the expected processing cost to ascertain the total budget required by the technical services system. Since the expected unit processing cost for the forthcoming year was estimated at \$6.18146. This unit processing cost could be multiplied by the expected monographs to be purchased to obtain the total expected processing cost for the forthcoming year ($\$6.18146 \times 17,525 = \$108,348.80$). Hence, the total expected budget for the technical services system would be \$275,186.80 for the forthcoming year.

As demonstrated, the MIS model developed by this research for the technical services system of an academic

library is general and flexible enough to accommodate any level of book budget and any number of monographs to be processed for the forthcoming year.

CHAPTER V

SUMMARY AND AREAS FOR FUTURE RESEARCH

The overall objective of the research was to develop a methodology for designing a management information system through which to bring about the effective technical services system of a university library. To achieve this objective a system of collecting and analyzing management information was developed which would allow the academic library manager to test alternative strategies of book selection. After this system was developed it was tested in an academic library to demonstrate its use and validity. The Duncan multiple-range test was incorporated to reveal which of the selection methods was most effective in terms of the average recorded use and the percentage of circulated monographs. An analysis of variance test and the multiple-range test were followed by a regression analysis in order to determine the expected average recorded use, the expected percentage of the monographs to be circulated and the expected average selection cost (average cost of monograph and average cost of selection) associated with each of the selection methods for the forthcoming year. The data ascertained through the use of the regression analysis were processed by applying the given

level of budget to generate a MIS indicating the expected number of monographs, the expected recorded uses and the expected number of monographs to be circulated for the forthcoming year. Through the management information system relative to book selection the management of a library was to select the best selection system from the alternatives in terms of the defined benefit criteria. The expected acquisitions under the best selection method forecasted by the management information system were related to the processing system to develop a management information system necessary for the management to define the resources required for processing the expected acquisitions for the forthcoming year. The results of the research testified to the fact that an academic library by using the methodological steps developed by this research could determine in advance the benefits and cost associated with the best book selection method for the forthcoming year. The research also indicated how to relate the work load predicted by the management information system pertaining to book selection to the processing system of the technical services system. The management information system related to book selection would aid the library management in building the best book collections at the minimum possible level of cost, while the information system pertaining to book processing would help the management keep the processing system in equilibrium by reducing the chances for overloading and underloading the workload on the system.

The management information systems which are interrelated in the context of the total technical service system were presented in Tables 11, 16, and 17. The information in Table 11 defined the most effective selection method for the management to choose. Table 16 summarized by the established categories the level of manpower and funds required to process the expected number of monographs, while the information summarized in Table 17 determined the level of personnel required for each activity of the technical service system for processing the expected acquisitions for the forthcoming year.

Future Research

This research, as noted in Chapter I, was primarily concerned with monographic titles in English language. Therefore, the most logical area for future research would be a study to determine the most effective book selection method in selecting the other types of materials, which were excluded from the scope of this research, not only for the past and present but also for the forthcoming year by using the method developed by this research.

Another area for further research with regard to book selection would be a study to develop a methodology for determining the best method in selecting materials by each of the subject areas listed in the catalog of a university. Such a study would enhance the quality of the library collections at the minimum level of cost.

Further research could be conducted to develop

a methodology to relate the book selection system to weeding the unused library materials from the actively used collections through a management information system.

The information resulting from the suggested research would aid the management of an academic library in improving its library collections both quantitatively and qualitatively.

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APPENDIX A

EFFECTIVE AVERAGE SALARY BY PERSONNEL CATEGORY AND UNIT
SUPPLY COSTS USED FOR DEVELOPING THE COSTING SYSTEM

A:1) Effective Average Salary of Professional Librarians*

1969-70	\$ 9,500.00
1970-71	\$ 9,975.00
1971-72	\$10,473.75
1972-73	\$10,997.44
1973-74	\$11,547.31
1974-75	\$12,124.68

A:2) Effective Average Salary of Clerical Staff

1969-70	\$ 4,926.00
1970-71	\$ 5,172.30
1971-72	\$ 5,430.91
1972-73	\$ 5,702.46
1973-74	\$ 5,987.58
1974-75	\$ 6,286.96

A:3) Unit Cost of Book Order Request Card

1969-70	0.7 cents
1970-71	0.735 cents
1971-72	0.77 cents
1972-73	0.81 cents
1973-74	0.85 cents
1974-75	0.89 cents

*The given costing data were used for the purpose of demonstrating the application of the methodology. The average salary of the beginning academic librarian reported by the Bowker Annual of Library and Book Trade Information was used in estimating the effective average salary (The Bowker Annual of Library and Book Trade Information, 1971, 1972, and 1973). Librarians' salary scale varies from region to region. Therefore, each library should use its own historical salary and fringe benefit data for forecasting the effective average salary for the forthcoming year.

A:4) Unit Cost of Multiple Order Form

1969-70	1.14 cents
1970-71	1.2 cents
1971-72	1.26 cents
1972-73	1.3 cents
1973-74	1.365 cents
1974-75	1.433 cents

A:5) Unit Cost of Multiple Catalog Card Sheet (6 card/sheet)

1974-75	3.53 cents
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A:6) Unit Cost of Card Easels

1974-75	1.875 cents
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A:7) Unit Cost of Book Pocket

1974-75	0.695 cents
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A:8) Book Card

1974-75	0.3 cents
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A:9) Unit Cost of Book Spine Label

1974-75	0.3 cents
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A:10) Unit Cost of Date Due Slip

1974-75	0.25
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A:11) Cost of Paste and Pastecloth per Book

1974-75	0.35
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APPENDIX B

UNIT TIME AND COST VARIABLES USED FOR DETERMINING
REGRESSION LINE VALUES REFLECTING THE EXPECTED
COST OF SELECTION BY EACH SELECTION METHOD FOR
THE FORTHCOMING YEAR

B:1) Unit Time and Cost of Selection by Librarian Selection Method for 1969-70

Activity	Standard Time in min.	Actual Labor Cost in Cents*	Supply Cost in Cents	Overhead Cost in Cents
Scan Select. Media	1.2 (p)	12.36		
Prepare Order Request	2.2 (c)	11.24	0.81	
Review by Acq. Librarian	.13(p)	1.3		
Searching	1.2 (c)	5.86		
Verification	7 (c)	32.55		
Dealer and Fund Assign.	.51(p)	4.8		
Prepare Order Form	5.14(c)	23.98	1.2	
Distribution of Order Form	1.3 (c)	6.06		
File Forms	2.2 (c)	10.5		
Total	20.88	108.65	2.01	5.533

Unit Cost of Selection = \$1.162

Unit Cost of Monograph = \$7.83

Total Unit Selection Cost = \$8.99

Hourly Overhead Rate = \$0.159

*It is assumed that 5% of the requests are rejected by the acquisition librarian, 5% of the approved items are returned to requesters during the process of searching and another 5% of the ordered items are cancelled by vendors or by the library for various reasons. These factors are considered in the imputation of cost to each activity whenever applicable. For example, the actual unit scanning cost is 12.36 cents although the unit labor cost is only 11 cents, for the unit scanning cost must be adjusted in accordance with the factors ($11 \times 1.15 = 12.36$). Each library should determine the percentages by an actual study.

B:2) Unit Time and Cost of Selection by Librarian Selection Method for 1970-71

Activity	Standard Time	Actual Cost	Supply Cost	Overhead Cost
Scan Selection Media	1.2 (p)	12.98		
Prepare Order Request	2.2 (c)	11.80	0.85	
Review by Acq. Librarian	.13(p)	1.37		
Searching	1.2 (c)	6.15		
Verification	7 (c)	34.18		
Dealer & Fund Assign.	.51(p)	5.04		
Prepare Order Form	5.14(c)	25.18	1.26	
Distribution of Order Form	1.3 (c)	6.36		
File Form	2.2 (c)	11.03		
Total	20.88	114.09	2.01	5.805

Unit Cost of Selection = \$1.219

Unit Cost of Monograph = \$8.14

Total Selection Cost = \$9.36

Hourly Overhead Rate = \$0.168

B:3) Unit Time and Cost of Book Selection by Librarian
Selection Method for 1971-72

Activity	Standard Time	Actual Labor Cost	Supply Cost	Overhead Cost
Scan Selection Media	1.2 (p)	13.08		
Prepare Order Request	2.2 (c)	12.39	0.89	
Review by Acq. Librarian	.13(p)	1.44		
Searching	1.2(c)	6.46		
Verification	7 (c)	35.89		
Dealer & Fund Assign.	.51(p)	5.29		
Prepare Order Form	5.14(c)	26.44	1.32	
Distribution of Order Form	1.3 (c)	6.68		
File Form	2.2 (c)	11.58		
Total	20.88	119.90	2.21	6.10

Unit Cost of Selection = \$1.280
Unit Cost of Monograph = \$8.52
Total Unit Selection Cost = \$9.80
Hourly Overhead Rate = \$0.175

B:4) Unit Time and Cost of Book Selection by Librarian
Selection Method for 1972-73

Activity	Standard Time	Actual Labor Cost	Supply Cost	Overhead Cost
Scan Selection Media	1.2 (p)	13.73		
Prepare Order Request	2.2 (c)	13.00	0.93	
Review by Acq. Librarian	.13(p)	1.51		
Searching	1.2 (c)	6.78		
Verification	7 (c)	37.68		
Dealer & Fund Assignment	.51(p)	5.55		
Prepare Order Form	5.14(c)	27.76	1.39	
Distribution of Order Form	1.3 (c)	7.01		
File Form	2.2 (c)	12.16		
Total	20.88	125.90	2.32	6.44

Unit Cost of Selection = \$1.35
Unit Cost of Monograph = \$9.16
Total Unit Selection Cost = \$10.51
Hourly Overhead Rate = \$0.185

B:5) Unit Time and Cost of Book Selection by Faculty
Selection Method for 1969-70

Activity	Standard Time	Actual Labor Cost	Supply Cost	Overhead Cost
Order Request Card			0.91	
Review by Acq. Librarian	.13(p)	1.3		
Searching	1.2 (c)	6.7		
Verification	7 (c)	32.55		
Dealer & Fund Assignment	.51(p)	4.8		
Prepare Order Form	5.14(c)	23.98	1.2	
Distribution of Order Form	1.3 (c)	6.06		
File Form	2.2 (c)	10.5		
Total	17.48	85.89	2.11	4.4

Unit Cost of Selection = \$0.924
Unit Cost of Monograph = \$8.27
Total Unit Selection Cost = \$9.20
Hourly Overhead Rate = \$0.15

*5% of the faculty requests are returned as the result of the review by the acquisition librarian, 20% of the accepted requests are returned to the requesters during the process of searching and another 5% of the orders are cancelled. The cost for each activity and supply reflects these factors.

B:6) Unit Time and Cost of Book Selection by Faculty Selection Method for 1970-71

Activity	Standard Time	Actual Labor Cost	Supply Cost	Overhead Cost
Overhead Request Card			0.96	
Review by Acq. Librarian	.13(p)	1.365		
Searching	1.2 (c)	7.035		
Verification	7 (c)	34.18		
Dealer & Fund Assignment	.51(p)	5.04		
Prepare Order Form	5.14(c)	25.18	1.26	
Distribution of Order Form	1.3 (c)	6.36		
File Order Form	2.2 (c)	11.03		
Total	17.48	90.18	2.22	4.62

Unit Cost of Selection = \$0.97
 Unit Cost of Monograph = \$8.69
 Total Unit Selection Cost = \$9.66
 Hourly Overhead Rate = \$0.16

B:7) Unit Time and Cost of Book Selection by Faculty Selection Method for 1971-72

Activity	Standard Time	Actual Labor Cost	Supply Cost	Overhead Cost
Order Request Card			1.01	
Review by Acq. Librarian	.12(p)	1.43		
Searching	1.2 (c)	7.39		
Verification	7 (c)	35.89		
Dealer & Fund Assignment	.51(p)	5.29		
Prepare Order Form	5.14(c)	26.44	1.32	
Distribution of Order Form	1.3 (c)	6.68		
File Order Form	2.2 (c)	11.58		
Total	17.48	94.69	2.33	4.85

Unit Cost of Selection = \$1.02
 Unit Cost of Monograph = \$9.26
 Total Unit Selection Cost = \$10.28
 Hourly Overhead Rate = \$0.168

B:8) Unit Time and Cost of Book Selection by Faculty Selection Method for 1972-73

Activity	Standard Time	Actual Labor Cost	Supply Cost	Overhead Cost
Order Request Card			1.06	
Review by Acq. Librarian	.13(p)	1.50		
Searching	1.2 (c)	7.76		
Verification	7 (c)	37.68		
Dealer & Fund Assignment	.51(p)	5.55		
Prepare Order Form	5.14(c)	27.76	1.386	
Distribution of Order Form	1.3 (c)	7.01		
File Order Form	2.2 (c)	12.16		
Total	17.48	99.42	2.45	5.09

Unit Cost of Selection = \$1.07

Unit Cost of Monograph = \$9.84

Total Unit Selection Cost = \$10.91

Hourly Overhead Rate = \$0.175

B:9) Unit Time and Cost Associated with Approval Program
for 1969-70

Activity	Standard Time	Actual Labor Cost	Supply Cost	Overhead Cost
Review by Librarian	1.5 (p)	14.10		
Distribution of Form	.9 (c)	5.7		
File Form	1 (c)	5.71		
Total	3.4	25.51		1.28

Unit Cost of Selection = \$0.268

Unit Cost of Monograph = \$8.52

Total Unit Selection Cost = \$8.79

Hourly Overhead Rate = \$0.225

Note: 5% of the monographs received under the approval program are rejected by the library.

B:10) Unit Time and Cost of Book Selection by Approval
Program for 1970-71

Activity	Standard Time	Actual Labor Cost	Supply Cost	Overhead Cost
Review by Librarian	1.5 (p)	14.80		
Distribution of Form	.9 (c)	5.98		
File Form	1 (c)	5.80		
Total	3.4	26.79		1.34

Unit Cost of Selection = \$0.28

Unit Cost of Monograph = \$9.07

Total Unit Selection Cost = \$9.35

Hourly Overhead Rate = \$0.236

B:11) Unit Time and Cost of Book Selection by Approval
Program for 1971-72

Activity	Standard Time	Actual Labor Cost	Supply Cost	Overhead Cost
Review by Librarian	1.5 (p)	15.54		
Distribution of Form	.9 (c)	6.28		
File Form	1 (c)	6.09		
Total	3.4	28.13		1.41

Unit Cost of Selection = \$0.30
 Unit Cost of Monograph = \$9.95
 Total Unit Selection Cost = \$10.25
 Hourly Overhead Rate = \$0.249

B:12) Unit Time and Cost of Book Selection Associated with
Approval Program for 1972-73

Activity	Standard Time	Actual Labor Cost	Supply Cost	Overhead Cost
Review by Librarian	1.5 (p)	16.32		
Distribution of Form	.9 (c)	6.59		
File Form	3.4	29.54		1.48

Unit Cost of Selection = \$0.31
 Unit Cost of Monograph = \$11.65
 Total Unit Selection Cost = \$11.96
 Hourly Overhead Rate = \$0.261

APPENDIX C

GLOSSARY OF TERMS USED IN THE STUDY

Acquisition Searching: Clerical staff check the approved items against the book order outstanding file and the public catalog to note whether the items are on order or already in the library. It is assumed that about 5% of the approved items are returned to the requesting librarians as the result of search.

Accessioning: Accession numbers are stamped on a rider slip and in a received item. The rider slip will be filed in the accession file after the item has been cataloged.

Accounting Routine: A copy of the multiple form is used for updating the internal accounting report for the item received.

Benefits: The term benefits refers to the recorded uses of library materials, the circulated number of monographs and the number of monographs associated with each of the selection methods. The number of uses made of the monographs and the number of the circulated monographs are considered as the primary criteria for measuring the effectiveness of the selection system; whereas, the number of monographs is considered as the secondary criterion.

Book Spine Labeling: The call number of each book is typed on a call number label, and the typed label is pasted on the spine of the book.

Card Inspection: Each of the finished cards is inspected by a professional cataloger to determine the accuracy and quality of the work performed by the clerk.

Card Production: Cards are reproduced from LC proofslips by using a xerox copier. The supply items needed for reproducing catalog cards include multiple catalog cards and card easels. An average set of cards for a title contains 6 cards. 5% of the cards are reproduced typed masters through a xerox copier.

Cataloging with LC Information: A Cataloger compares the LC proofslip with book, determines the acceptability of subject headings and classification. 95% of the monographs in English language are catalogued with LC proofslips. The standard time for cataloging an item with LC proofslip is 14.12 minutes.

Cataloging without LC Proofslip: Cataloging without LC proofslip involves: (1) bibliographic search by clerical staff, (2) establishing main and added entries by cataloger, (3) description of books, (4) establishing subject headings, and (4) assigning classification number. The unit standard time assigned to professional librarian is 27.53 minutes, and the unit time assigned to clerical staff is 5.6 minutes.

Check in Shelf List: Cataloger checks to note if there is discrepancy between information on a LC proofslip and items in the shelf list.

Dealer and Fund Assignment: Librarian assigns a dealer, fund and order number to each of the verified items.

Distribution of Order Forms: Orders are sorted by

vendors and they are sent out.

Expected Average Selection Cost: This cost is defined for the purpose of study to include the expected average cost of monograph and the expected average cost of selection. The terms is used to compare the costs associated with alternative strategies of book selections.

Filing Cards: The inspected catalog cards are separated from the shelflist cards and arranged in an alphabetical order. The arranged cards are dropped on the rods in catalog card drawers by a clerk, and a professional librarian revises the filing of the cards before the cards are locked into drawers. It is assumed that the library uses the dictionary catalog. The shelflist cards are filed in the same manner as the catalog cards.

Filing of Order Forms: The receipt and processing copies of the order form are filed in the on-order file, and one of the copies is filed in the public catalog.

Invoice Routines: A clerical staff review the invoice and approves it for payment. The approved invoice is sent to the business office for payment.

LC Proofslip Searching: A clerical staff searches for a LC proofslip in the proofslip file, removes the slip and inserts it in item.

Pasting Operation: A clerk pastes the pocket and date due slip in the back by using regular book paste.

Planning: Strategic planning is defined as "the

process of determining the objectives that determine the ways to achieve the objective" (Steiner, 1969); whereas, tactical planning refers to the processing of determining how to achieve the objective. The term, therefore, refers in this study to both strategic and tactical planning.

Preparation of Multiple Order Form: A clerical staff types a multiple order form for each verified item, proof reads the form and separates the part of the form.

Preparing Order Request: A selected item is typed on a book order request card. The information to be typed onto the request card should be as complete as possible.

Receiving Routine: Non-professional staff unpack, sort books and check to see if items, received are as ordered. The processing copy of the multiple is inserted in an item received, and the actual cost of the item and date received are recorded in the receipt copy of multiple form. 5% of the orders are cancelled.

Review by Acquisition Librarian: All the requests are reviewed and approved by the acquisition librarian for further processing.

Scanning Selection Media: Librarians scan various selection media, such as publishers' blurbs, choice review cards, Publishers' Weekly, etc., and select items for purchase. It is assumed that about 5% of the librarian selections are rejected by the acquisition librarian.

Shelflisting: One of the main entry cards with the

call number is used as the shelflist card. To the card the usual shelflist information is added.

Sorting of Processing Materials: The book card, book pocket and date due slip are matched with the corresponding book to prepare for pasting operation.

Typing Book Cards: A clerk types the call number, the last name of the author, brief title and accession number on a circulation card, and inserts into the book.

Typing Cards: A clerical staff types subject headings, added entries and call numbers onto sets of reproduced cards.

Use Pattern: The term use pattern refers to the average recorded use and the percentage of the monographs circulated in the context of this research.

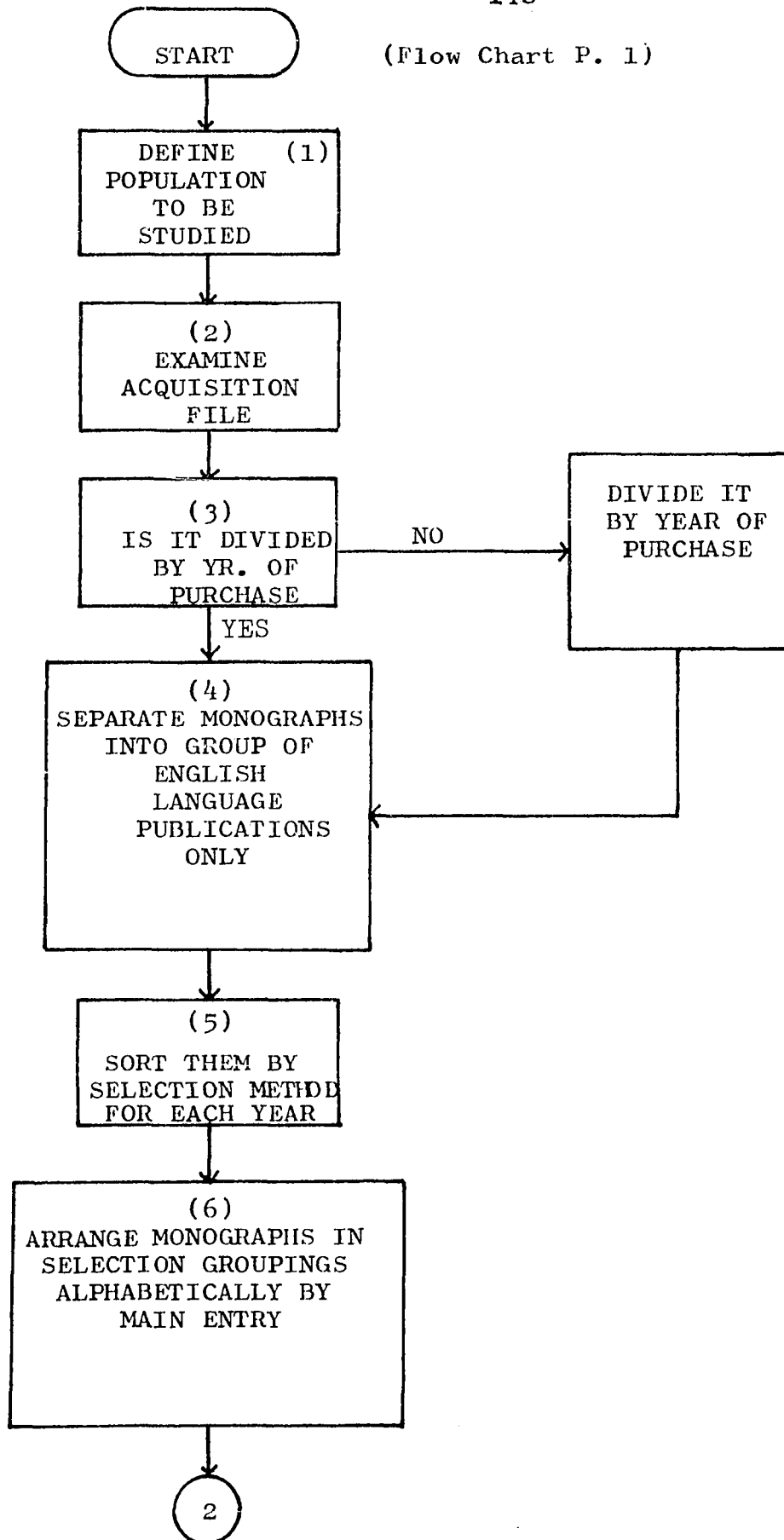
Variable Expenditure: Variable expenditure is used to denote the wages and salary of a library's employees, and the cost of informational materials.

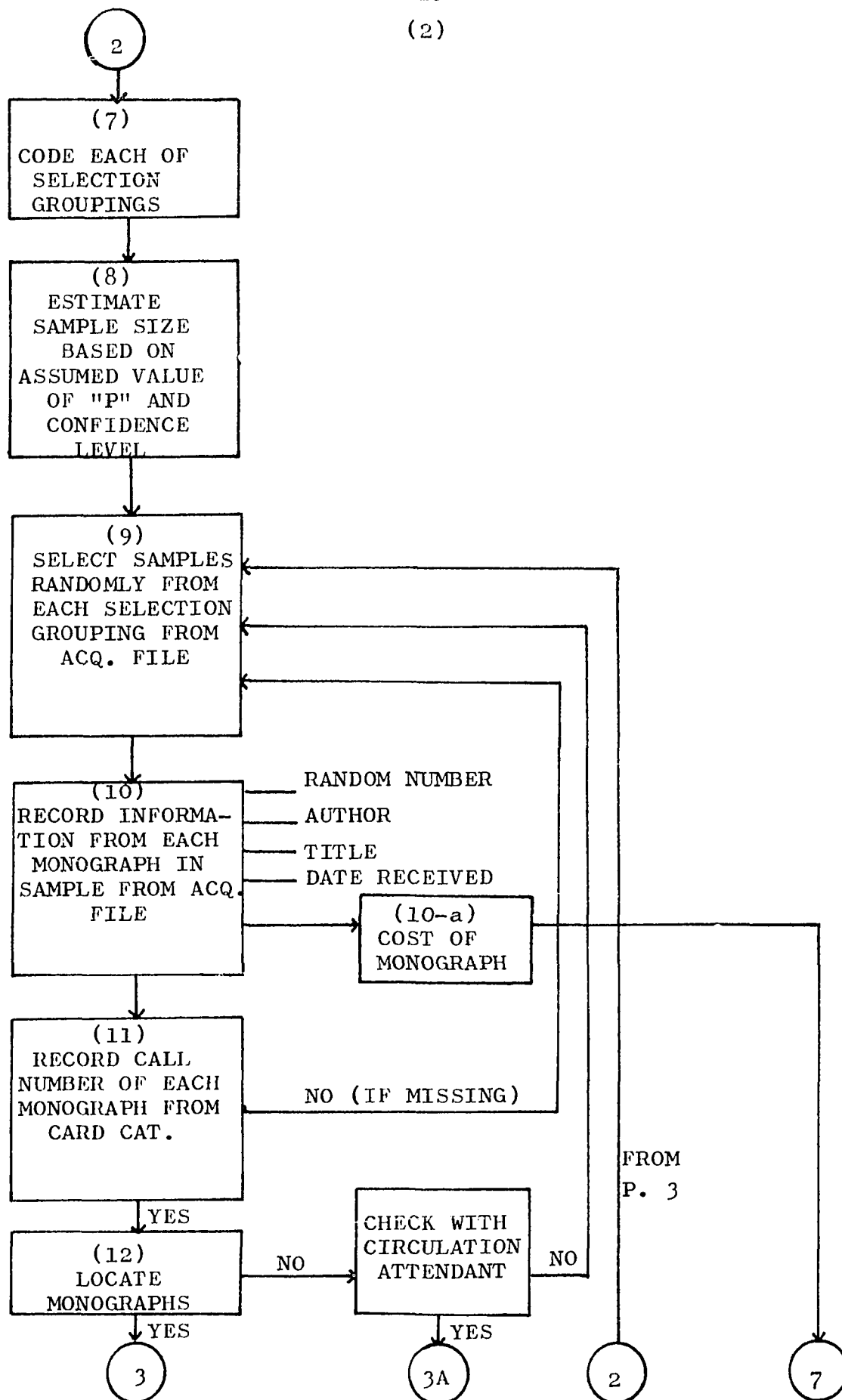
Verification: The searched items are verified in standard bibliographic sources to establish main entry, complete missing trade bibliographic information and determine LC catalog card number.

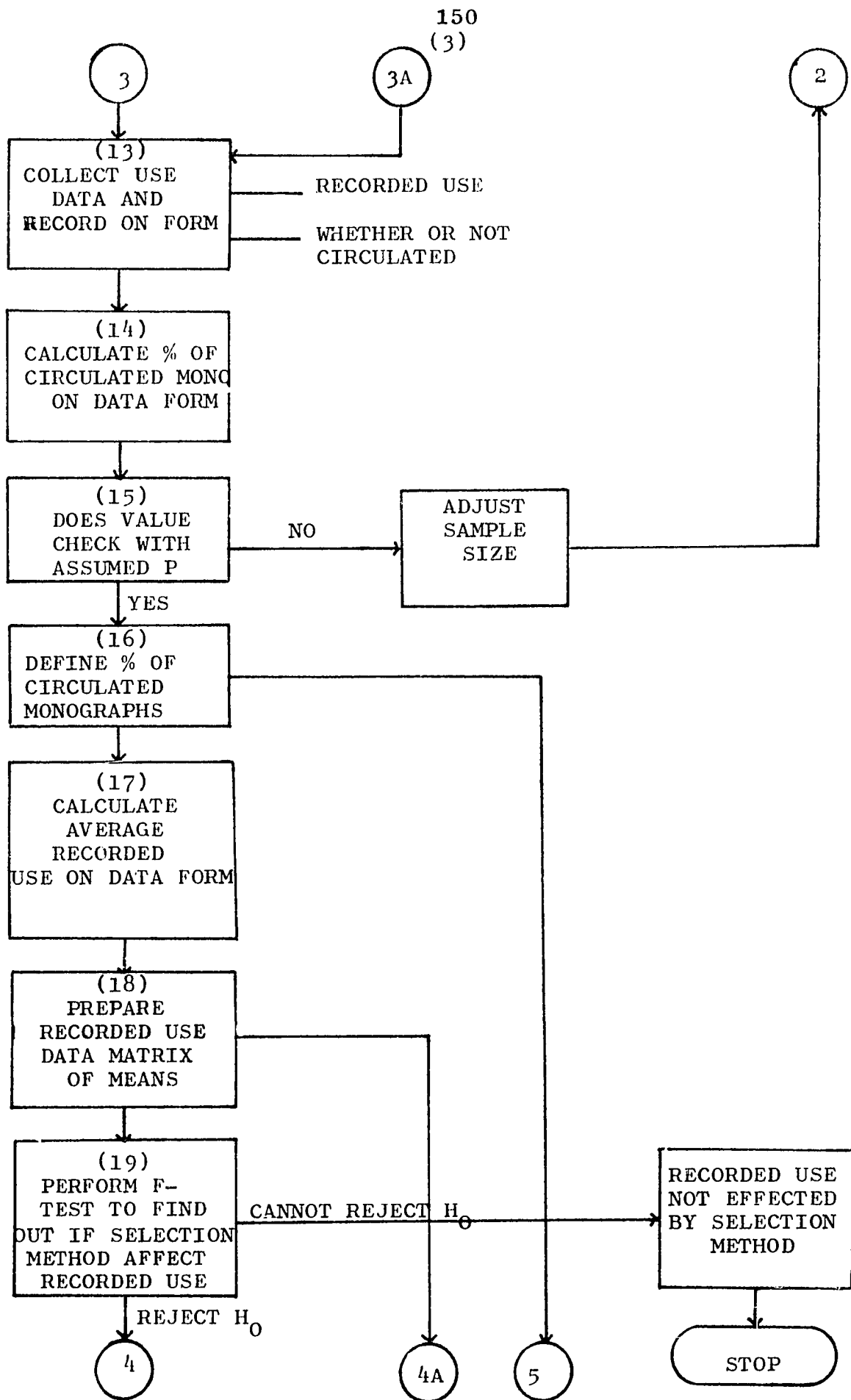
APPENDIX D

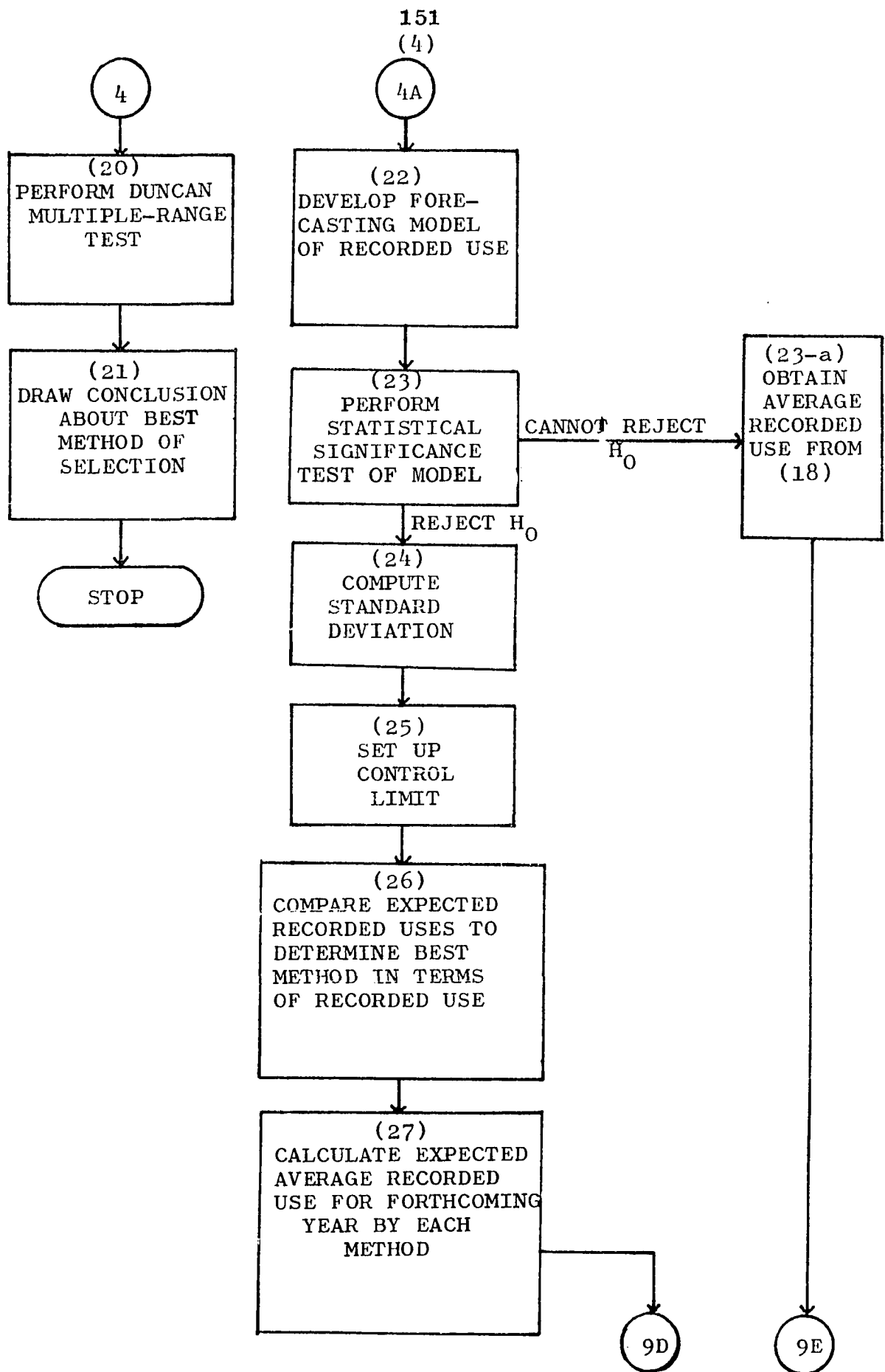
FLOWCHART SHOWING PROCEDURAL STEPS FOR DEVELOPING BOOK SELECTION MIS MODEL

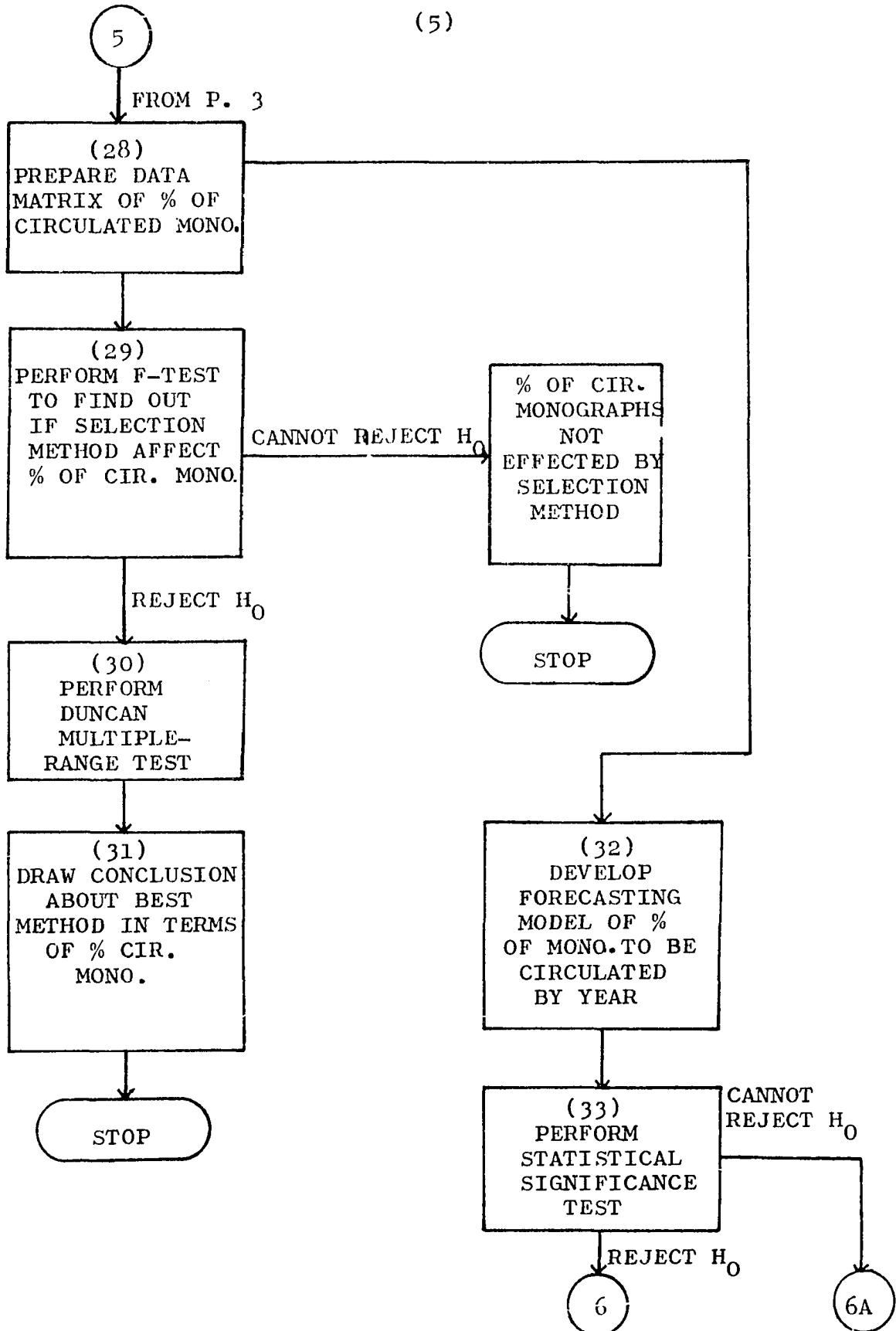
(Flow Chart P. 1)

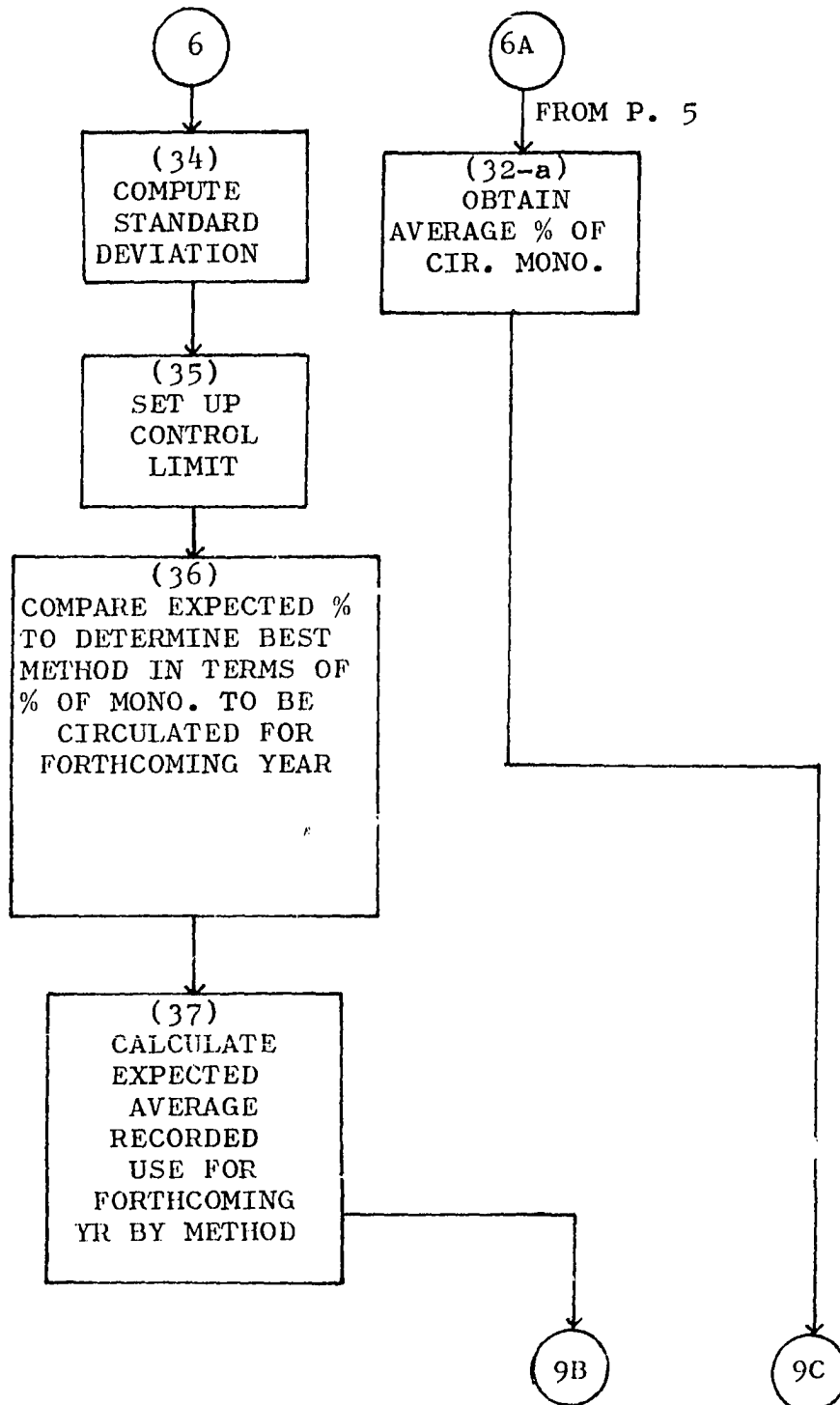


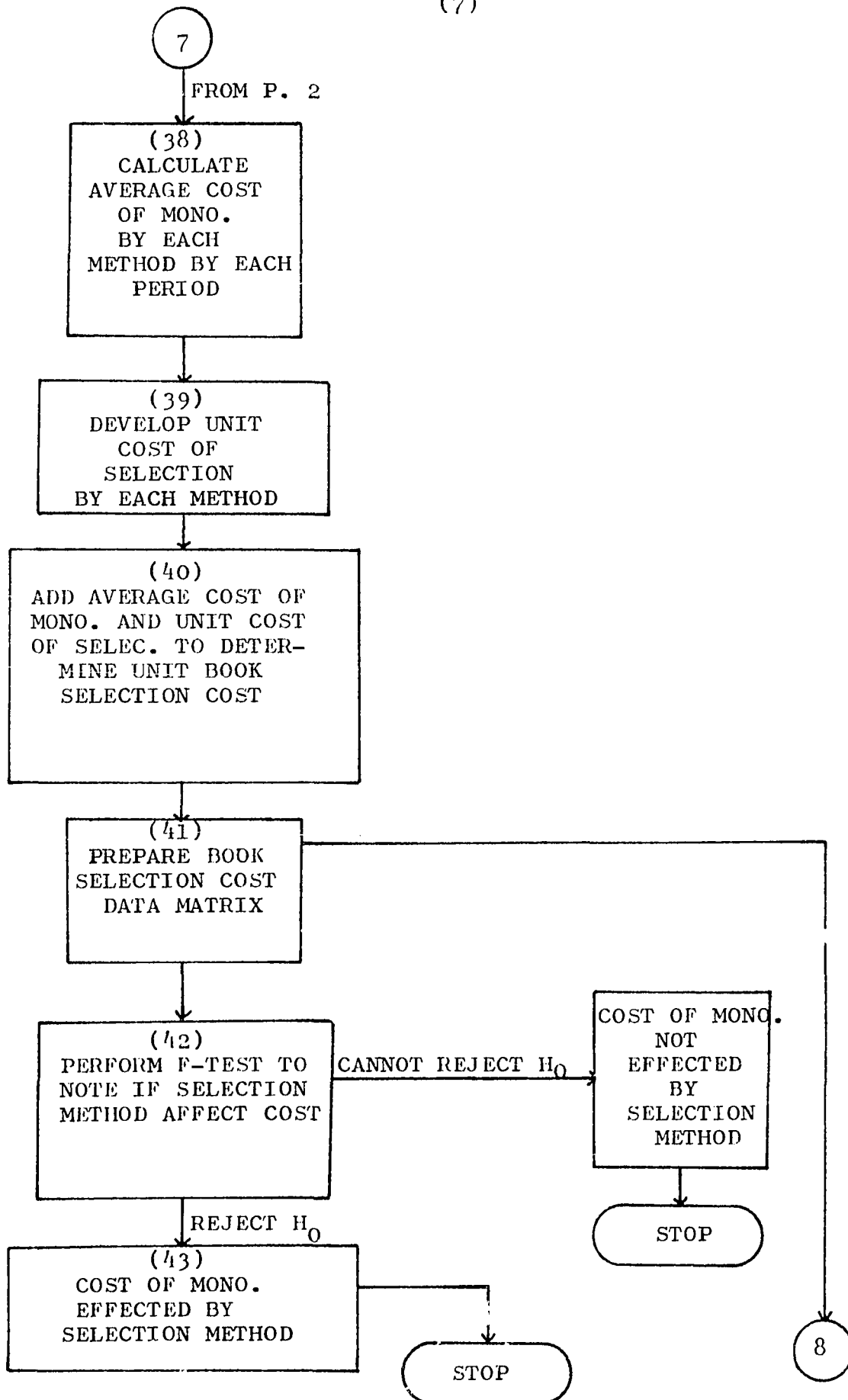


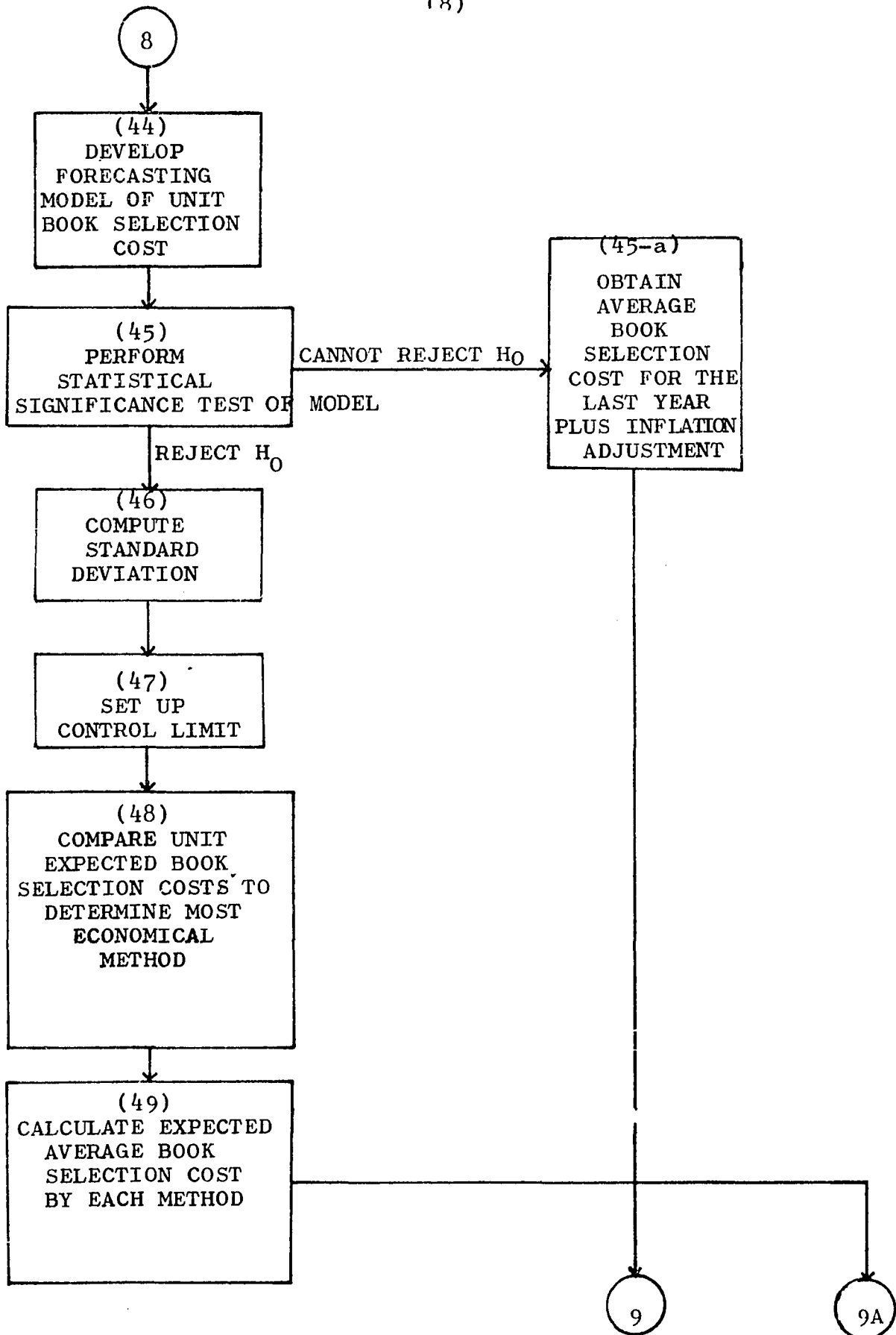






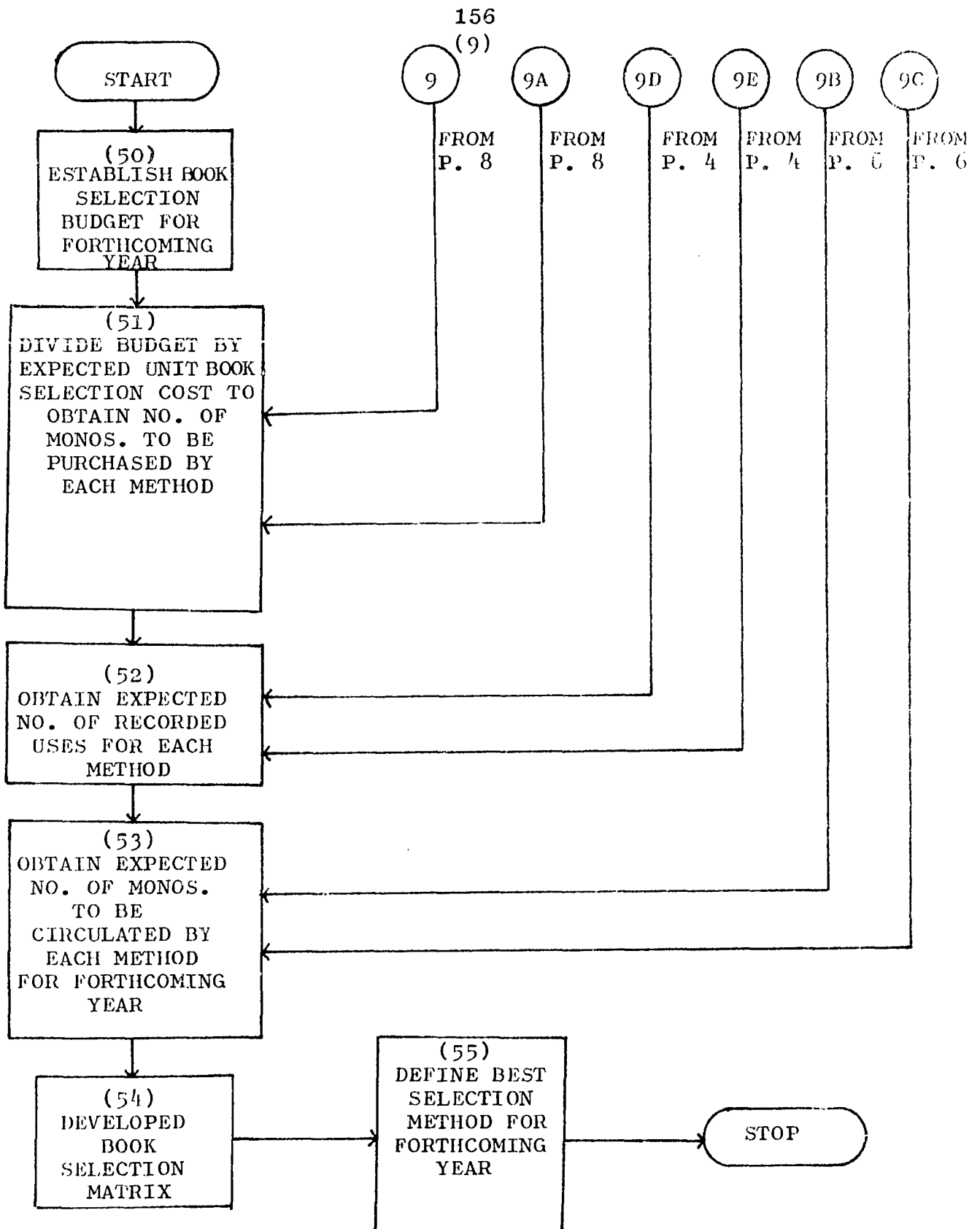


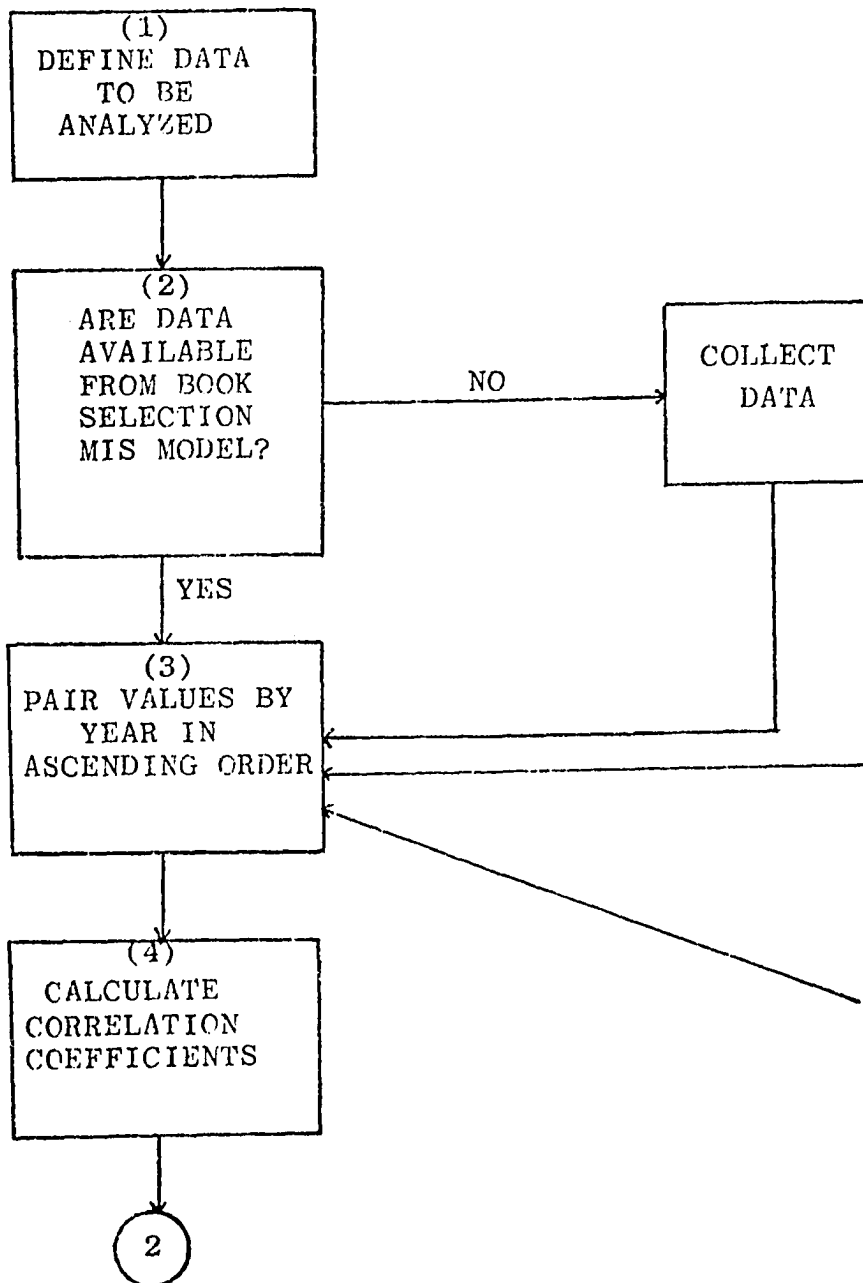




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FLOWCHART FOR CORRELATION ANALYSIS OF RECORDED USE AND
PERCENTAGE OF CIRCULATED MONOGRAPH

RECORDED USE DATA
CAN BE OBTAINED
FROM THE PRE-
CEDING FLOWCHART,
STEP 18

DATA REFLECTING
THE PERCENTAGE OF
CIRCULATED MONO-
GRAPHS MAY BE
OBTAINED THE PRE-
CEDING FLOWCHART,
STEP 27

