THE UNIVERSITY OF ASTON IN BIRMINGHAM

DEPARTMENT OF BUILDING

AN INVESTIGATION OF THE CONTRACTOR'S USE OF BILLS OF QUANTITIES

THESIS SUBMITTED FOR THE DEGREE OF

MASTER OF SCIENCE

by

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JULY 1974

SUMMARY

The bill of quantities is a document extensively used throughout the building industry, and has remained substantially unaltered since the introduction of the first edition of the Standard Method Of Measurement Of Building Works in 1922.

This research answers the question, what use is the bill of quantities to the contractor today?

A detailed investigation was made within one contracting company, to identify, firstly, every activity where bills of quantities are used, and secondly, the specific information used from the bill by each of those activities.

In addition to use, the research also examines the 'value' of information. A method of measuring information value, capable of recording any change resulting from different use, was developed.

The results identify the procedure which makes the greatest use of the bill, identifies also the specific information most frequently used, and name the variety of tasks which the bill serves. The results compare use and 'value' and calculates the 'values' for specific information as well as procedures.

By considering the time scale from tender to final account, the research establishes when the greatest use of the bill occurs* and demonstrates that this use far exceeds that at the tender stage.

The results further show that disparity exists between the 'values' of individual information packages used at different times and for different purposes, indicating the need for a more appropriate structure.

* There is of course the fact that at the tender stage the use made of the bill of quantities should be multiplied by the factor of the number of companies competing.

A C K N O W L E D G E M E N T S

The author wishes to express his sincere thanks to A. H. Wootton, B.Sc., A.I.Q.S., L.I.O.B., Department of Building, University of Aston in Birmingham for his helpful supervision and guidance throughout this research, also to R. J. Cruickshank, B.Sc., Ph.D., M.Inst.P., Department of Building, University of Aston in Birmingham, for his advice and assistance in the preparation of the computer programme and the selection of the scoring rules, also to the contractor, who wishes to remain anonymous, for making this investigation possible.

The author also wishes to thank H. E. Walker, M.Eng., F.I.C.E., F.I.Mun.E., F.I.O.B., Head of Department of Civil Engineering and Building, Lanchester Polytechnic, for allowing this research to be conducted at the University of Aston in Birmingham.

C O N T E N T S

CHAPTER PAGE NO.

CHAPTER PAGE NO.

LIST OF FIGURES

PAGE NO.

CHAPTER VI (Continued)

CHAPTER VII

PAGE NO.

CHAPTER VII (Continued)

PAGE NO.

CHAPTER VII (Continued)

CHAPTER VIII

APPENDIX A

PAGE NO.

APPENDIX A (Continued)

APPENDIX D

C H A P T E R I

INTRODUCTION

1.1 The Purpose of Measurement

> "When we mean to build, we first survey the plot, then draw the model; and when we see the figure of the house, then must we rate the cost of erection." (1)

or to express it a different way:-

> "But don't begin until you count the cost. For who would begin construction of a building without first getting estimates and then checking to see if he has enough money to pay the bills?" (2)

The practice of calculating the monetary value of a building project before committing oneself either to build on the one hand, or accepting responsibility for the erection on the other, has been a discernable activity in building for many hundreds of years. Once the model of the building has been drawn and the figure of it seen, some translation of the artifice into measurable units, against which cost commitments may be set, is evidently essential before the total cost of erection may be calculated.

Flanagan suggests in his Historical Study of Construction Industry Measurement Practice that bills of quantities were first prepared "in approximately 1800".(3)

The prime objective of a bill of quantities has remained predominantly the same, namely to identify the items within a building project which contribute to the total contract sum and present them in such a manner as to facilitate quick and easy pricing. Bills of quantities, which are mainly produced by the professional surveyor, provide competing contractors with a uniform tendering document, thereby enabling their tender bids to be evaluated objectively and a successful tenderer chosen.

There was, however, little uniformity in the practice of measuring building work until 1922 when the first Standard Method of Measurement of Building Works was published. The building industry not only recognised the advantages of uniformity, but has also gained from rationalizing its tendering procedure.

The purpose served by building measurement is therefore twofold, firstly, it enables a drawn model to be expressed in monetary terms, and secondly, it provides a vehicle whereby the experience gained on one project may be related to another.

1.2 Object of Research

In the past 50 years there have been significant developments within the building industry in the areas of materials, construction methods, erection processes, the utilization of heavy plant, management techniques and control procedures, all using information with an individual bias.

Regarding information, Daltry and Warrington state that "the management of building work depends above all on good communications, on what is communicated and when." "Information may be said to be constructions most vital yet underrated resource."(4)

The contractor's increased demand of information has resulted in a greater use of the bill of quantities, producing criticism from areas of contracting which the document was not primarily designed to serve. Two questions emerge, firstly, how much is the bill of quantities used by the building contractor, and secondly, how useful is the information to him?

The purpose of this research is firstly to identify, within a representative company, the detailed activities where bills of quantities are used, secondly to identify the specific information used for each activity, and thirdly, to formulate a method whereby the value of bill of quantities information may be calculated, enabling a comparison of values for different information to be made.

This research does not examine bills of quantities for civil engineering work.

C H A P T E R I I

EXISTING WORK

2.1 The Standard Method of Measurement

Since 1922 there have been five editions of the Standard Method of Measurement of Building Works published jointly by The Royal Institution of Chartered Surveyors and The National Federation of Building Trades Employers. These editions reflect an awareness by the members of these professional bodies of the changing demand for information, and a desire to formulate rules appropriate to a developing industry.

Although different editions have regrouped sections of work, and revised the measurement units of many items, the fundamental concept of measuring work inclusive of labour and material fixed in position has remained unaltered.

Despite these revisions made to the practice of measuring building work, the diversity of opinion relating to the efficiency and suitability of bills of quantities as a means of satisfying the construction industries' need of information at the tender stage, and particularly during the construction period, is frequently the subject of professional enquiry, articles in the technical press and comment at institution meetings.

2.2 Elemental and Sectionalised Trade Bills

In an attempt to satisfy the information needs of the contractor, and provide a document more appropriate to the needs of the quantity surveyor, the elemental bill was introduced in which the measured work could be grouped in functional elements. The advantage being to relate the quantities of work to production. In 1956 a quantity surveyors' committee investigated the use of elemental bills and concluded:-

> "the reaction of builders generally is at the present unfavourable to the elemental bill of quantities chiefly on the grounds that tendering is made more complicated."(5)

Sectionalised trade bills were introduced in the second half of the 1950's with the purpose of combining the advantages observed in elemental bills with those of traditional billing methods, at the same time eliminating the disadvantages of the elemental format encountered during the tendering period. In the sectionalised trade format, the measured work was "arranged basically in trades with each trade sub-divided into functional elements."(6)

Although many of the objections raised against the elemental bill were avoided in this format, its use has not become widespread within the industry.

2.3 Presentation and Format of Bills of Quantities

In 1959 a quantity surveying techniques working party

was established by the cost research panel of the Royal Institution of Chartered Surveyors "to consider the systems and operations for which the bills of quantities may be used."(7) It was suggested that the study might include:-

> "A. The Historical development of the bill of quantities.
>
> B. The present features of the bill and information therein.
>
> C. The uses of the bill for:-
>
> (a) Tendering.
>
> (b) Costing and management techniques by professions, by building contractors and by other bodies.
>
> D. The compilation of the bill in relation to its uses for (a) and (b) above and developments in the methods of presenting the bill."(8)

The working party found they were unable to consider all the points mentioned in the guidance notes, and therefore judiciously selected those aspects of the brief where some conclusion could be reached or some effective statement made in the time available.

With respect to the presentation features of the bill and its compilation relating to its use for tendering, costing and management techniques, the working party concluded:-

> "Neither the current form of trade bills nor elemental nor sectionalised trade bills appear to be susceptible to amendment which would enable contractors to relate site costs to bill prices. All current forms of the bill are too detailed for this purpose but the detail is claimed by contractors to be essential for tendering purposes at the present time."

> "It does not appear practicable to devise amendments to bills in their present form which would materially assist contractors in ordering materials or bonusing labour: the present form is useful only as an overall check of the contractor's own measurements made for these purposes."

> "The difficulty of reconciling the tendering, contractural, analytical and management needs within the framework of the bill emphasises the necessity to study reprocessing the data in the dimensions to suit various pre- and post-tendering needs."

> "If additional analytical or management information is required and is to be given purely by reprocessing the original dimensions, the requirements must be known at the time when the dimensions are prepared. Reprocessing alone is expensive, reprocessing involving adjustment of the original dimensions is very expensive for the quantity surveyor though this expense may well be justified by the usefulness of the data to the industry as a whole."(9)

Two of the significant points identified by the working party were firstly, that the contractor's information requirement must be known, and secondly, the usefulness of data may well be the factor to justify any additional revisions to the basic measurements. However, the information requirements were not fully known and therefore the usefulness of data could not be ascertained.

The working party therefore recommended:-

> "That further research projects on the uses and presentation of the bills of quantities be carried out jointly with architects or contractors or preferably with both."(10)

In October of 1965 The Standardisation Working Party, composed of quantity surveyors, architects, builders and estimators published a report on the "Presentation and Format of Bills of Quantities". Their brief was:-

> "To collect information and obtain aswide a point of view as possible on
>
> (a) the practicability and desirability of introducing standardisation in the presentation and format of bills of quantities; and
>
> (b) the use of information contained in bills of quantities for purposes other than tendering, i.e. for costing, bonusing, ordering, programming, estimating and pricing."(11)

Since the range of topics included in the brief were so broad, the working party decided to limit their investigation to matters of principle, which of course excluded any detailed investigation of the contractor's use of the bill of quantities.

On the question of standardisation the working party recommended that:-

> "urgent consideration be given to a study in detail of a universally acceptable standard method of describing items and mode of expression for the building industry with a view to obtaining the greatest advantage from the use of computers."(12)

In pursuance of this recommendation Leonard Fletcher and Thomas Moore produced their "Standard Phraseology for Bills of Quantities"(13), which subsequently received recommendation from the Royal Institution of Chartered Surveyors for general use in the production of bills of quantities.

An immediate advantage was recognised by quantity surveyors in achieving standardisation of language and uniformity of construction descriptions, and therefore the use of "Standard Phraseology" in bills of quantities grew. It did not, however, contribute to a greater understanding of the contractor's use of the bill of quantities.

2.4 The Rationalisation of Measurement

The Rationalisation of Measurement prepared by Ferry and Holes[14] was an initial investigation into a fundamental study of measurement procedures in the construction industry. The study investigated in detail the process and systems of measurement in current practice, and discussed the possibility of introducing a single integrated system of measurement. In addition to making a very significant contribution to the understanding of interrelated measurement systems, the report made specific recommendations regarding future development of measurement practice. It did not, however, attempt to identify either specific tasks using bills of quantities or the information such tasks would require from the bill.

2.5 The Link Computer System

Although developed in a "closed" situation, this system[15] clearly demonstrates the contractor's interest in measured data and the ability to manipulate original measurements to satisfy

the information requirements of functions other than tendering. Rather than being discouraged by the "closed" and exceptional circumstances surrounding this development, one should be encouraged by the results to investigate in detail the general contractor's use of and need for measured information, since only by understanding these requirements in detail will effective development occur.

2.6 The Operational Bill

In the early 1960's the Building Research Station, now the Building Research Establishment, developed the "Operational Bill"[16], totally different in concept from traditional bills, and using a system of measurement other than the Standard Method of Measurement of Building Works[17].

To produce an operational bill, the building project was first analysed into a number of operations, each capable of completion by one man, or gang of men without interruption by others, and arranged sequentially by using as precedence diagram. These operations were then used to form the basis of the bill structure. The work in each operation was then divided into two parts, labour and material, the material element being grouped either operationally or written as one schedule and cross-referenced to the relevant operation. In either case a schedule of factory made components was listed and billed separately.

The aim of this bill was to make estimating easier and more accurate, and also provide information in a format suitable

for production use. Since its introduction, the use of this bill within the industry has not grown significantly.

2.7 Communications in the Building Industry

The National Joint Consultative Committee of Architects, Quantity Surveyors and Builders commissioned the Tavistock Institute of Human Relations in 1964 to conduct a pilot study into "Communications in the Building Industry"[18]. Being only a pilot study their report could only discuss communication patterns and difficulties and identify the scale of the problem. However, the report recommended that:-

> "research be undertaken on the basis of protected experiments into the interdependent operations of the building process concurrently with studies of the roll and relationships of the building team members involved."[19]

This report stimulated a wide interest in the general question of communications in building.

In 1968 the working party on Data Co-ordination was established by the National Consultative Council of the Ministry of Public Building and Works, now the Department of the Environment,

> "to consider proposals for the improvement of information flow in the construction industry; to advise on all measures necessary to implement the proposals taking into

> "account the need to secure widespread industrial co-operation in the adoption of any uniform system and the need for compatability as far as possible with existing development in or affecting the industry."(20)

In order that their study should be comprehensive and achieve a worthwhile result within a realistic period of time, a number of research teams were established to investigate, Architectural Design(21), Structural Engineering(22), Mechanical Engineering Services(23), Electrical Design and Contracting(24), Quantity Surveying Product Manufacture and Merchanting(25), Contractors Management(26), and Instructions to Operations(27). These reports were summarized(28) in an integrated manner to show the benefit of a rationalised system of information.

> "Implementation", it was stated, "would appear to be justified by savings in cost, quite apart from the benefits stemming from the use of more advanced techniques, from optimised design, from the avoidance of abortive work, from better management information to designers, constructors and suppliers."(29)

Nine further research teams were established(30) in order to complete this fundamental study of building information. Commenting on the work of one research team which considered the structuring of project information, the final report of the working party on data co-ordination stated:-

> "We consider one of the highest priorities for data co-ordination to be the development of an improved and standardised structure for project information both as an aid to communication and as a basis for rationalisation of the procedures and processes of design and construction. The

> "subject covers a wide field and includes the content and preparation of drawings, specifications, bills of quantities and other documents."(31)

In the report submitted by the team concerned with the structuring project information, a comprehensive list of information sources was identified, and a wide variety of information requirements established. This work did not, however, attempt to identify the individual contribution made by the information sources to the various needs.

In the conclusions of their report they state:-

> "The quality and completeness of the information itself is more important than the way in which it is structured."(32)

> "Work should be put in hand to ascertain users' and producers' information needs in greater depth than we have been able."(33)

> "The possibility of providing documents which facilitate the separation of the tender/payment and the production control functions of the bill of quantities should be investigated."(34)

2.8 Civil Engineering Bills of Quantities

Although there is a clear distinction between building and civil engineering bills of quantities, the research conducted by Dr. N. M. L. Barnes and P. A. Thompson for the Construction Industry Research and Information Association entitled Civil Engineering Bills of Quantities(35) has developed a number of

concepts which may be equally appropriate to bills of quantities for building work. A new bill of quantities called the "Method Related Bill" was developed, in which several different types of cost could be identified by the contractor, those relating to the quantities of permanent work and those relating to the methods and timing of construction. The method-related charges are included against items inserted and described by the contractor and the quantitive charges are set against quantities of finished work measured in accordance with a simplified civil engineering standard method of measurement. The advantages claimed for the bill are:-

(1) Improved financial control of civil engineering activity with reduced administrative costs.

(2) Payment for work done more equitable to both parties.

(3) Less contention and delay in agreeing payment.(36)

As a preliminary requisite to this work over 80 organisations within the civil engineering industry were interviewed to ascertain their use of existing bills of quantities. The investigation covered the whole field of financial planning, estimating and control, and drew upon experience and current practice. Although this aspect of identifying the occurrence and purpose of bill of quantities use was thoroughly and comprehensively covered, the actual information used from the bill at each occurrence was not ascertained, nor was any method devised to assess the value placed upon such information by the contractor.

2.9 Current Developments

In January 1971 the Royal Institution of Chartered Surveyors and the National Federation of Building Trades Employers appointed a joint working party to examine the practice of measurement in the building industry. Their brief called for an historical review of the factors leading to the agreement over the existing Standard Method of Measurement and then by examining criticism on the one hand, and evidence of those who call for change in methods of presenting project data on the other, to consider the feasibility of extending the concept of the Standard Method of Measurement into areas of production, planning and control, and finally to make recommendations.

In producing their report, published in 1972, the working party not only considered the criticisms levelled at the Standard Method of Measurement, but also reviewed all current research in this area, in order to comprehend the information problems and the concept of a prime data source, and to ensure total objectivity in reaching conclusions and recommendations. Their conclusions and recommendations introduced a number of things new to building documentation:-

> "It is of the utmost importance that some way be found to reflect in bills of quantities the financial relevance of organizational and managerial issues."(37)

> "Bills of quantities should separately identify items with regard to the characteristics of quantity; time; occurrence and value."(38)

> "It would be advisable to lay down suitable methods of measurement for work at several levels of detail."(39)

> "Primary measurements taken by the quantity surveyor should be made available to all contracting parties."(40)

> "We see the Standard Method of Measurement of the future as an instrument for codifying the description and measurement of building work at a series of related levels rather than at the single - traditional bill of quantities orientated - level of previous editions."(41)

It is significant, that since the publication of their report a Standard Method of Measurement Working Party has been established.

Clearly, if all that is envisaged is to be accomplished, a considerable amount of detail development and investigation must be undertaken.

2.10 Conclusion

From an examination of the developments in bills of quantities and measurement information, the question of the contractor's use of the bill of quantities remains unanswered in any detail, and certainly no attempt has been made to identify the value placed upon such information by the contractor. To identify the use made of the bill of quantities by the contractor and the value placed upon it, will not only help to satisfy an existing need, but will open a considerable area of investigation.

CHAPTER III

METHODOLOGY

3.1 Preliminary Fieldwork

A company was selected of a significant size and organisation, containing specialist departments and using modern management and construction techniques, since these reflect the developments of modern technology in the construction industry. Specialisations, either in the type of work undertaken, construction methods used or the manner of obtaining work were to be avoided, since each of these factors tend to attract special systems peculiar to the company and would not be truly representative of the industry. Two additional aspects to be considered were the type of experience which the company had, this should be as broad as possible, and the value of contracts undertaken, which should be wide ranging. The contractor could therefore be considered to be experienced in using the many forms of bills of quantities produced by quantity surveyors.

A national construction company with approximately sixty million pounds annual turnover of work was asked to act as the model for the research. It was explained that data would be obtained by interview with senior members of the company and subjective measurements taken. The contractor readily agreed to participate and offered every assistance.

A pilot study of the company was undertaken, the purpose being to discover the structure of the organisation, its departments and sections, their responsibilities and the degree of isolation or integration of one department with another, and identify the procedures and chains of command established as normal patterns of working.

Before any data relating to the use and performance of the bill of quantities could be collected, the structure of the analysis of such data had to be decided upon. Two structures were considered, firstly a departmental analysis, and secondly a functional analysis.

The analysis of "Contractors Procedures" as detailed in Structuring Project Information[42] was chosen as a suitable framework for the analysis of data.

The procedures listed in the report Structuring Project Information were made known and discussed with the contractor.

A number of bills of quantities with differing formats were examined to find a method of subdivision so as to formulate a wide ranging and comprehensive list of items upon which data could be collected. The information gained was analysed and grouped into twenty-seven separate information packages, it is acknowledged that assistance was gained from the report Structuring Project Information[43] in settling some points of demarcation. Each information package was then defined. These definitions were then examined in conjunction with the contractor to determine the suitability of the grouping and the accuracy of the definitions.

3.2 Data Collection

The "Contractors Procedures" from the report Structuring Project Information[44] was divided into two parts, those procedures which used the bill of quantities and those which did not. Those procedures using the bill of quantities were further subdivided into tasks, each task representing a separate and significant operation within the procedure.

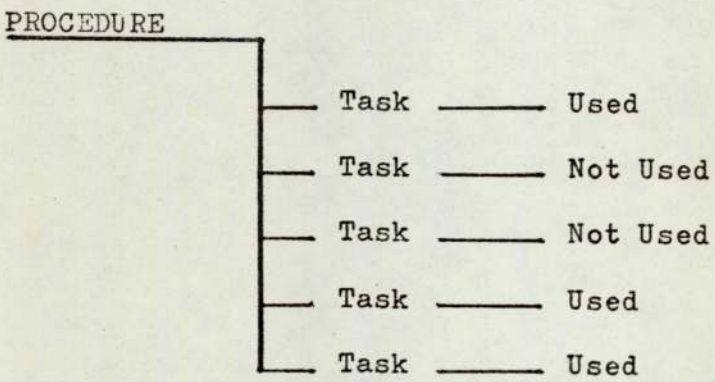

FIGURE 1

DIVISION OF TASKS INTO USERS AND NON-USERS OF THE BILL OF QUANTITIES

The division of tasks into users and non-users required careful analysis of the job specification and information requirement of each task, and was subject to constant re-examination.

A comprehensive schedule of tasks each making direct reference to the bill of quantities emerged for the whole building process.

The next stage identified which of the twenty-seven bill of quantities information packages were used to satisfy the

information requirement of each of the tasks. These information packages were then considered, and a method developed whereby the significant factors of value could be isolated, and then by mathematically combining these, produce a numerical value for each information package used.

3.3 Analysis

Having identified the principal factors of information value there remained the problem of combining these two scales. Several mathematical combinations and values were tested and one chosen which best reflected the fluctuation of information value to the contractor. A computer programme was considered and written to manipulate the data. The results were then examined, interpreted and observations made.

CHAPTER IV

PRELIMINARY FIELDWORK

4.1 The Pilot Study

The pilot study essentially formulated an understanding of the company and its methods of business procedure, its annual turnover of work in monetary terms, and reviewed the number of persons directly employed. Together these gave some indication of company growth and size rather than organisational capacity.

Further it explained the structure of the major sections, the departments within sections, the service functions of departments and the normal pattern and structure of site organisation.

The information gained from the pilot study not only ensured that the correct departments and persons were visited and interviewed in the later stages of the research, but it also eliminated the possibility of missing some aspect or enquiry because of company organisation.

A detailed account of the pilot study is contained in Appendix A.

4.2 The Structure of the Analysis

4.2.1 Defining a Suitable Structure. Two methods of analysing the bill of quantities data were considered, firstly by departmental use and secondly by fundamental activities. The first method whilst having certain merit of immediate application to one company, clearly would be inappropriate as a scientific basis of investigation, since departmental titles, job specifications, the size and responsibility of departments are not consistent throughout the industry. However, to structure the analysis into activities, identifiable within any construction company, would mean that the adverse effects of company structure, departmental size and responsibility would not be incorporated into the results, also the results of the research may be directly compared with those obtained from other companies of different size and organisation.

The study of "Coding and Data Co-ordination for the Construction Industry"[45] analyses the building process into three sections, design, design realisation and construction, with a fourth section of management common to all three. These sections are described as functions[46]. In the study, the function of construction, the area of this research investigation, is defined as "the planning of work, including financial budgeting and control, and the allocation, acquisition and deployment of resources on site to achieve the completion of a project"[47].

Each of the functions contain a number of procedures, defined as "formalized ways of executing tasks having identifiable end points"[48]. Procedures are the fundamental divisions

within a function and are independent of company size and organisation. Each procedure is further sub-divided into basic activities called tasks.

The structure of functions, procedures and tasks, see Figure 2, was appropriate as a basis for analysing the bill of quantities data.

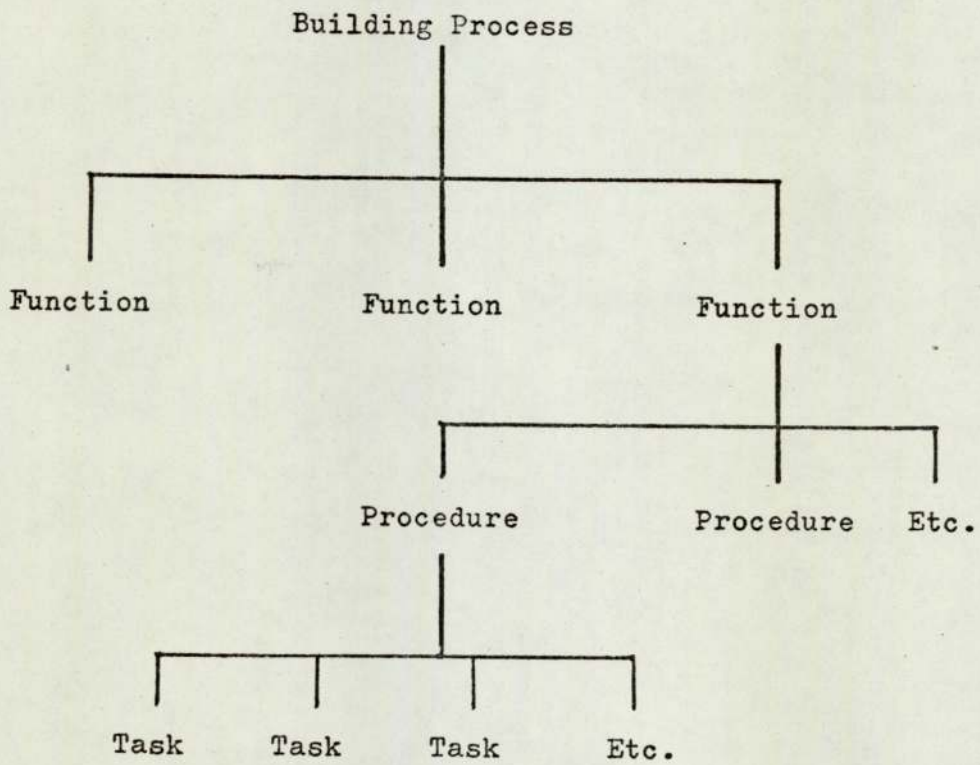

FIGURE 2

THE BASIC STRUCTURE OF THE ANALYSIS

4.2.2 The Selected Structure. The Structuring of project information discussed in "An information System of the Construction Industry"[49] states:-

> "We consider one of the highest priorities for data co-ordination to be the development of an improved and standardised structure for project information both as an aid to communication and as a basis for rationalisation of the procedures and processes of design and construction. The subject covers a wide field and includes the content and preparation of drawings, specifications, bills of quantities and other documents, their assembly and cross-referencing, and their mode of presentation to all the participants in the total design and build process."

Clearly the establishment of a standardised structure of information would include, among other criteria, the contents of bills of quantities and their use by the members of the building process. Therefore to structure the analysis of bill of quantities data collected in this research in a standardised format would serve two purposes. Firstly, it would identify, within a standard structure, the performance of existing documents and deficiences of information quality and secondly, it would identify areas in the building process where opportunity exists for improving the total use of such information.

The report "Structuring Project Information"[50] which studies the arrangement and presentation of information for building projects, was a subsidiary study for the National Consultative Council's Working Party on Data Co-ordination for the Construction Industry. The basic structure of information within this report is therefore compatible with the structure of functions, procedures and tasks. The contractor's procedures necessary for the execution of a typical building contract obtained by competitive tender are shown in Figure 3[51].

Although this analysis of procedures was developed primarily as a structure for the entire spectrum of information and documents consulted by the contractor during the construction period of the building process, it was nevertheless recognised as a significant structure, with appropriate classifications for the analysis of bill of quantities data.

The tasks within each individual procedure were not identified by the report Structuring Project Information and were therefore obtained by research within the contracting company.

4.3 Information Packages

4.3.1 Information in Bills of Quantities. It is the common practice in the building industry to prepare bills of quantities for contracts in excess of £10,000 when competitive tenders are required. The report of the Joint Working Party on Measurement Conventions[52] states:-

> "Ideally a bill of quantities should provide a list of items representing, by means of appropriate parameters, sub-divisions of total cost which are pertinent to the construction process, each suitably quantified and guaranteed for accuracy by the employer, and each capable of sustaining, for the currency of a contract, a justifiable price.
>
> "A bill of quantities should afford a quick appreciation of the general complexity, value and scope of the contract works and be capable of being priced not only accurately but rapidly and cheaply."

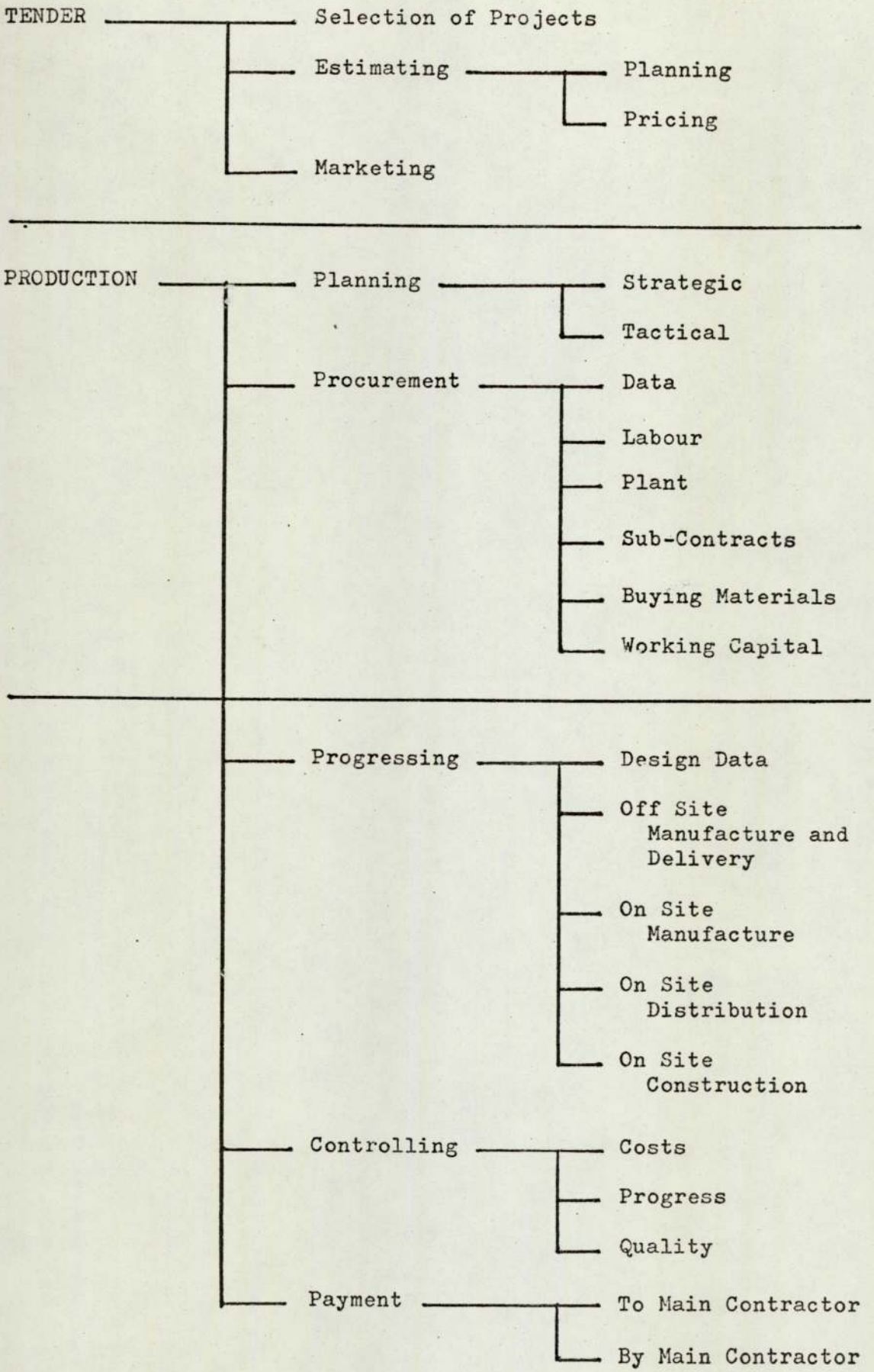

FIGURE 3

SUMMARY OF CONTRACTOR'S PROCEDURES

The quantity and quality of work included in the contract sum as defined in the Standard Form of Building Contract[53] is "deemed to be that which is set out in the Contract Bills which bills unless otherwise expressly stated in respect of any specified item or items shall be deemed to have been prepared in accordance with the principles of the Standard Method of Measurement of Building Works."[54]

That bills of quantities define the works in accordance with the Standard Method of Measurement of Building Works is confirmed by Wood[55] in his statement "a bill is supplied containing in accordance with the accepted mode of the Standard Method of Measurement, a complete and tabulated list of detailed items, together with their respective quantities and full descriptions."

With particular reference to the building work, the Standard Method of Measurement identifies the items which are measurable, defines the units of measurement, specifies, where applicable, classification stages into which measurements are grouped, and states the constituent information elements necessary to describe work items.

In addition to the information relating directly to the measured work two further areas of information are specified within the document. Firstly, provisional and prime cost sums[56], which relate to the inclusion of sums of money rather than measured quantities and secondly, preliminaries[57], which include items requiring careful definition since they affect the total contract sum but are not part of the building fabric.

The clauses which specify the quality of materials and the standard of workmanship to be used, called trade preambles, are normally grouped separately. The Presentation and Format of Bills of Quantities[58] states "trade preambles for each work section should be grouped together and each section produced on a separate page to facilitate circulation to sub-traders."

Four basic groups of information are therefore contained within bills of quantities, preliminaries, preambles, the measured work and provisional and prime cost sums. Although these are fundamental areas of information it does not follow, with the exception of preliminaries, that these sections are always grouped separately, in fact bills of quantities have taken their names from the method of sortation and presentation of this information.

4.3.2 Definitions of Information Packages. Bills of quantities of many different formats were examined and from them a comprehensive list of items abstracted under the headings of preliminaries, preambles, measured work and provisional and prime cost sums. The items within these sections were then resorted into twenty-seven packages. For ease of identification and uniformity of interpretation at the interviewing stage each package was given a title as follows:-

1. Project Details
2. Site and Location
3. Form of Contract
4. Times and Phasing

5. Financial Details
6. Statutory Details
7. Facilities and Services
8. General Responsibilities
9. Material Specification
10. Workmanship
11. Handling and Placing Materials
12. Tests and Samples
13. Locational Details
14. Work Quantities
15. Quantity Units
16. Unit Rates
17. Rate Extension
18. Extension Totals
19. Work Description
20. Description Dimensions
21. Provisional Quantities
22. Temporary Works
23. Demolitions
24. P.C. Sums Nominated Suppliers
25. P.C. Sums Nominated Sub-Contractors
26. Provisional Sums
27. Contingency

The definitions of these information packages are contained in Appendix C.

CHAPTER V

DATA COLLECTION

5.1 Procedures

The Summarised List of the Contractor's Procedures in Structuring Project Information[59] was discussed with the contractor and the parameters of each procedure identified to facilitate the selection of procedures into users and non-users of the bill of quantities. Fourteen of the twenty-two procedures discussed were identified as using information from bills of quantities. The analysis of the procedures is shown in Figure 4.

Careful examination of the non-user procedures revealed that their information requirement consisted of either a subjective assessment of known facts and the manipulation of previously used data as in the case of Tender Marketing, or the request for clarification and amplification of incomplete or amended sections of the design as in the case of Production - Progressing - Design Data, or monitoring actual achievement with planned performance as in the case of Production - Controlling - Progress, none of which may be directly satisfied from current bills of quantities. A schedule of procedure definitions obtained from Structuring Project Information[60] is contained in Appendix B.

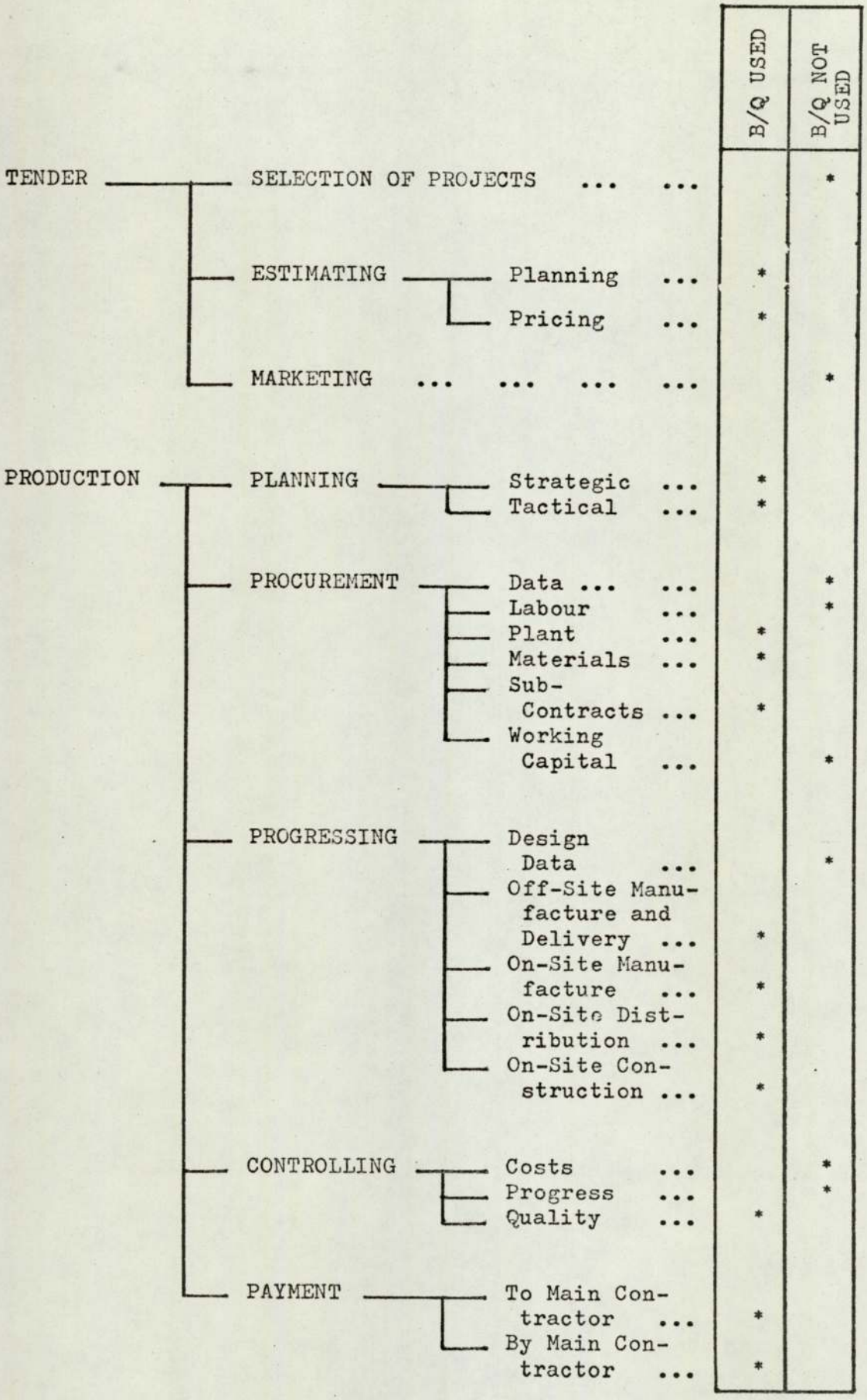

FIGURE 4

ANALYSIS OF PROCEDURES USING BILLS OF QUANTITIES

Before proceeding with the data collection, two amendments to the list of procedures were introduced. Firstly, the procuring of sub-contracts was sub-divided into two groups, domestic sub-contracts and nominated sub-contracts and suppliers. The division of domestic and nominated letting was considered by the contractor to be sufficiently different to warrant separate examination. Secondly, the contractor indicated that it would be extremely difficult to provide any accurate subjective opinion relating to the use of the bill of quantities for the procedure of on-site construction, even though it had been correctly identified as using this information, since its use would greatly depend upon the type and form of the structure and would clearly fluctuate from one job to another. This procedure was therefore omitted from the investigation.

Figure 5 (page 33) shows the fourteen procedures which were further investigated to ascertain their individual use of bills of quantities.

5.2 Identification of Tasks

Each of the departments contributing to the total constructional activity embraced within the fourteen procedures directly using the bill of quantities, were revisited to sub-divide their work into tasks. For this sub-division the contractor was asked to consider two criteria, firstly that each task should represent a separate and significant operation of work, and secondly, that all tasks should be of similar importance. To avoid ambiguity or misunderstanding in the task titles, a senior

No.	PROCEDURE
1	Tender Estimating Planning
2	Tender Estimating Pricing
3	Production Planning Strategic
4	Production Planning Tactical
5	Production Procurement Plant
6	Production Procurement Materials
7	Production Procurement Domestic Sub-Contractors
8	Production Procurement Nominated Sub-Contractors and Suppliers
9	Production Progressing Off-Site Manufacture and Delivery
10	Production Progressing On-Site Manufacture
11	Production Progressing On-Site Distribution
12	Production Controlling Quality
13	Production Payment to Main Contractor
14	Production Payment by Main Contractor

FIGURE 5

SCHEDULE OF PROCEDURES USING BILLS OF QUANTITIES

member of staff from each department first recounted the total activity of his department.

By systematic evaluation of the information criteria for

each task an analysis was effected, and those tasks not directly referring to the bill of quantities deleted from the schedule of tasks. The rejected tasks were again re-examined by the contractor to confirm the accuracy of his identification. A schedule of tasks for the whole building process each making direct reference to the bill of quantities was identified as follows:-

PROCEDURE 1

Tender Estimating Planning

Tasks:-

(1) Materials and Nominated Suppliers

(2) Labour

(3) Plant

(4) Nominated Sub-Contractors

(5) Domestic Sub-Contractors

(6) Project Overheads

PROCEDURE 2

Tender Estimating Pricing

Tasks:-

(1) Materials and Nominated Suppliers

(2) Labour

(3) Plant

(4) Nominated Sub-Contractors

(5) Domestic Sub-Contractors

(6) Project Overheads

(7) Establishment Overheads

PROCEDURE 3

Production Planning Strategic

Tasks:-

(1) Appoint agent, works manager and general foreman

(2) Select engineers and sub-agent

(3) Select site facilities required, e.g. huts, water

(4) Plan construction method

(5) Select trade foreman and gangers

(6) Review contract period and tender details

(7) Prepare approximate programme and review tender documents

(8) Examine buying file and review material quotations

(9) Insurances

PROCEDURE 4

Production Planning Tactical

Tasks:-

(1) Identify major items of initial construction, select construction method and type of plant to be used

(2) Select work for letting to Domestic Sub-Contractors

(3) Check measure main quantities of work

PROCEDURE 5

Production Procurement Plant

Tasks:-

(1) Select plant and prepare method statement of working for larger items

(2) Procurement of plant

PROCEDURE 6

Production Procurement Materials

Tasks:-

(1) Measure for material ordering

(2) Review tender documents and quotations

(3) Develop enquiry

PROCEDURE 7

Production Procurement Domestic Sub-Contractors

Tasks:-

(1) Decision to sub-contract

(2) Review tender documents and quotations

(3) Develop enquiry

PROCEDURE 8

Production Procurement of Nominated Sub-Contractors and Suppliers

Tasks:-

(1) Review tender documents

(2) Selection of Sub-Contractor/Supplier

PROCEDURE 9

Production Progressing Off-Site Manufacture and Delivery

Task:-

(1) Off-site manufacture and delivery

PROCEDURE 10

Production Progressing On-Site Manufacture

Task:-

(1) On-site manufacture

PROCEDURE 11

Production Progressing On-Site Distribution

Task:-

(1) On-site distribution

PROCEDURE 12

Production Controlling Quality

Task:-

(1) Controlling quality of material and workmanship

PROCEDURE 13

Production Payment to Main Contractor

Tasks:-

(1) Identification of type of construction work

(2) Size and location of contract

(3) Review tender documents

(4) Prepare interim valuations

(5) Remeasure variation orders

(6) Prepare dayworks

(7) Calculate increased costs

(8) Prepare Domestic Sub-Contractor's measurement and final account

(9) Prepare Nominated Sub-Contractors and Suppliers measurement and final account

PROCEDURE 13 (continued)

Production Payment to Main Contractor

Tasks:-

(10) Calculate claims

PROCEDURE 14

Production Payment by Main Contractor

Tasks:-

(1) Invoice received and account paid for materials

(2) Invoice received and registered for Domestic Sub-Contractors

(3) Prepare measurement and agree account for Domestic Sub-Contractors

(4) Accounts and invoices received from Nominated Sub-Contractors and Suppliers

(5) Prepare the measurement and agree the accounts for Nominated Sub-Contractors and Suppliers

The inter-relationship and occurrence of tasks within the procedures of tender estimating planning and pricing, production planning strategic and tactical, production procurement of materials and production payment to contractor, which constitute the more significant users of the bill of quantities are shown in Appendix D, Figures - . Figure of Appendix D shows the cyclic patterns and inter-relationship between the procedures of production payment to main contractor and production payment by main contractor.

5.3 Identification of Information Used

A subjective assessment of the information used from bills of quantities for each of the tasks identified could now be made. To assist the contractor in the process of selection, an "Identification Schedule" was prepared, see Appendix E, on which the contractor recorded the information used. By careful evaluation the contractor determined which information packages were used for each task. Although this process was tedious and time-consuming, each decision was checked and confirmed before being finally accepted. The result was the identification of the use made of the bill of quantities throughout the total building function, classified into procedures and tasks. This data is contained in Appendix E.

5.4 The Value of Information

5.4.1 Factors Affecting Value. The next objective was to establish a method by which the value of information to the contractor could be identified. Information was investigated within the concept that the major factors of information value may each be graded and given a numerical score, and then by mathematically integrating these scores produce one measurable value for each information package.

By interview and discussion with the contractor, the value of information appeared to be determined primarily by two factors, sufficiency and accuracy. These factors were adopted as the basic headings for the assessment. Since all information

has the potential to be either sufficient or insufficient, accurate or inaccurate it was necessary to develop scales one for sufficiency and one for accuracy, each capable of reflecting the significant points of change from very good to very poor.

Since information value was to be a subjective measurement, the number of options on each scale were kept to a minimum, to enable the contractor to make a realistic selection.

5.4.2 Sufficiency. In trying to establish a graded scale for sufficiency, thought was given to the source and availability of the information used to supplement the bill of quantities, and whether this information or any part of it could be incorporated into the bill of quantities at the time of production. A scale with four options was developed, each option unmistakably different, producing a gradation from totally sufficient to insufficient. The four points on this scale were:-

(1) Information self-supporting, i.e. self-sufficient.

(2) Bill of quantities read in conjunction with other client documents.

(3) Bill of quantities read in conjunction with other client documents and/or contractor's documents.

(4) Bill of quantities read in conjunction with other client documents and/or contractor's documents and/or external documents.

5.4.3 Accuracy. It was assumed for the purpose of establishing factors of accuracy that the bill of quantities was an accurate measurement of the proposed building, prepared in accordance with the Standard Method of Measurement of Building Works. A discussion with the contractor relating to accuracy of information revolved around accuracy relative to specific use, and the suitability of the presentation format. Again, a four point scale was developed giving a gradation from accurate to inaccurate. The four points on this scale were:-

(1) Bill of quantities information accurate and in a usable format.

(2) Bill of quantities information accurate but format requires revision.

(3) Bill of quantities information inaccurate but presented in a usable format.

(4) Bill of quantities information inaccurate and format unusable.

5.4.4 Sufficiency and Accuracy Data. By combining the sufficiency and accuracy scales on one schedule, see Appendix F, the rating of sufficiency and accuracy for each information package used per task could be identified simultaneously. Like the process of "Identifying Information Used", this process of collecting sufficiency and accuracy data was unfortunately time-consuming since the selections could only be made by senior members of the staff, experienced enough to comprehend the whole picture and evaluate the options available. Fifty-four schedules,

one for each task, were completed to give the total summary of sufficiency and accuracy of bill of quantities information. The schedules for Procedure 1 - Tender Estimating Planning are included as a sample in Appendix F.

5.5 Tasks in Time Order

Analysis of the data collected could be made either by procedures, tasks, or information packages. A fourth analysis, that of total concept was required. This could be achieved by reassembling all the tasks, previously identified, into a time sequence running throughout the whole construction function.

Since contract periods vary from contract to contract, and the length of time required to complete each task also varies according to the degree of complexity, time in this context could only relate to the starting and finishing points of each task relative to all others. The five significant project dates relative to all projects using bills of quantities in traditional tendering conditions, see Figure 6, provided the framework around which all the tasks were built.

Starting at Procedure 1 - Tender Estimating Planning, a senior member of the tendering department was asked to plot the starting and finishing points of the six tasks in that procedure, relative to each other, and relative to the significant project dates. This process of relating tasks progressed from one procedure to another, but at all times staff had the opportunity to examine and amend any earlier decision in light of the developing

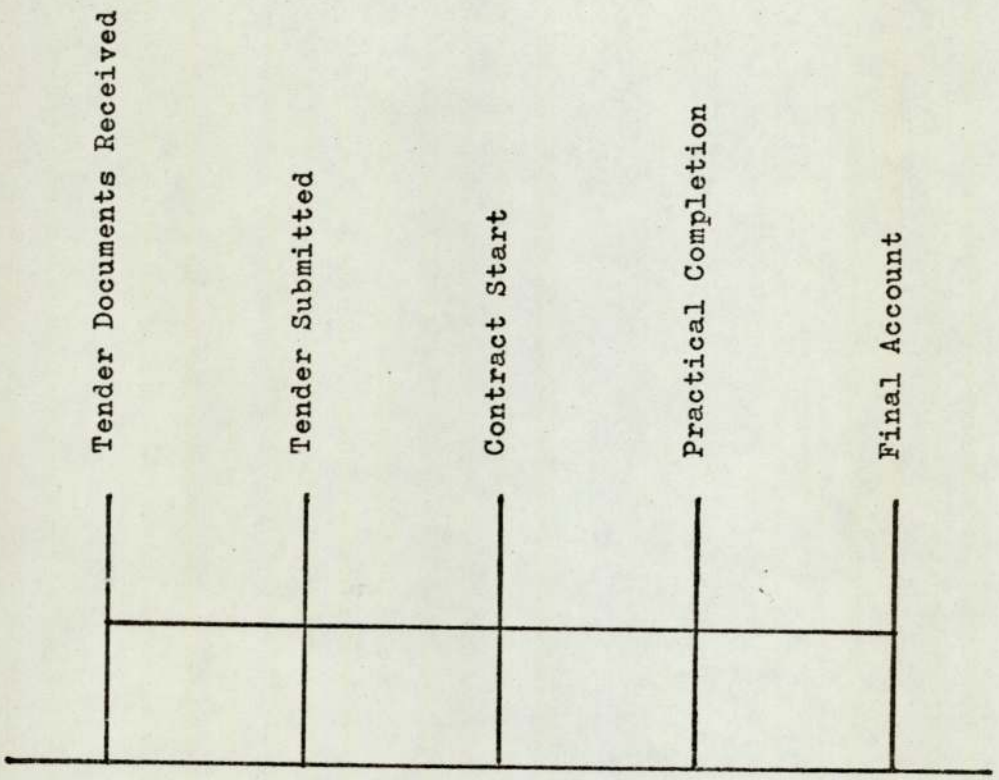

FIGURE 6

SIGNIFICANT PROJECT DATES

picture. By this method each task was located in a time sequence relative to all other tasks, see Figures 7 and 8 .

From the methods of analysis now available a comprehensive picture of the actual use and possible use of the bill of quantities may be observed. Also in cases where information value is low, specific reasons for this may be identified.

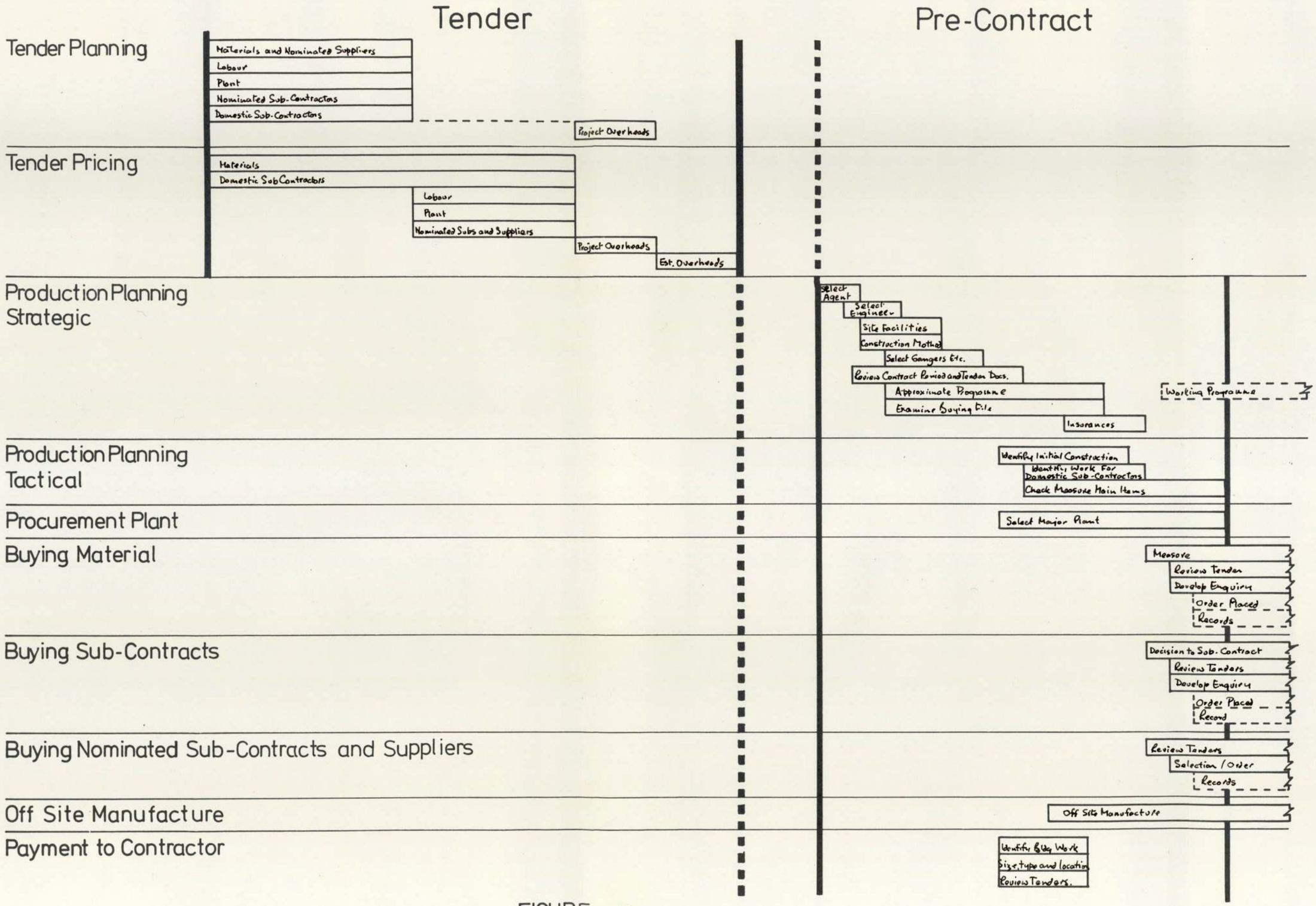

FIGURE 7

TASKS IN TIME SEQUENCE FOR TENDER AND PRE-CONTRACT PERIODS

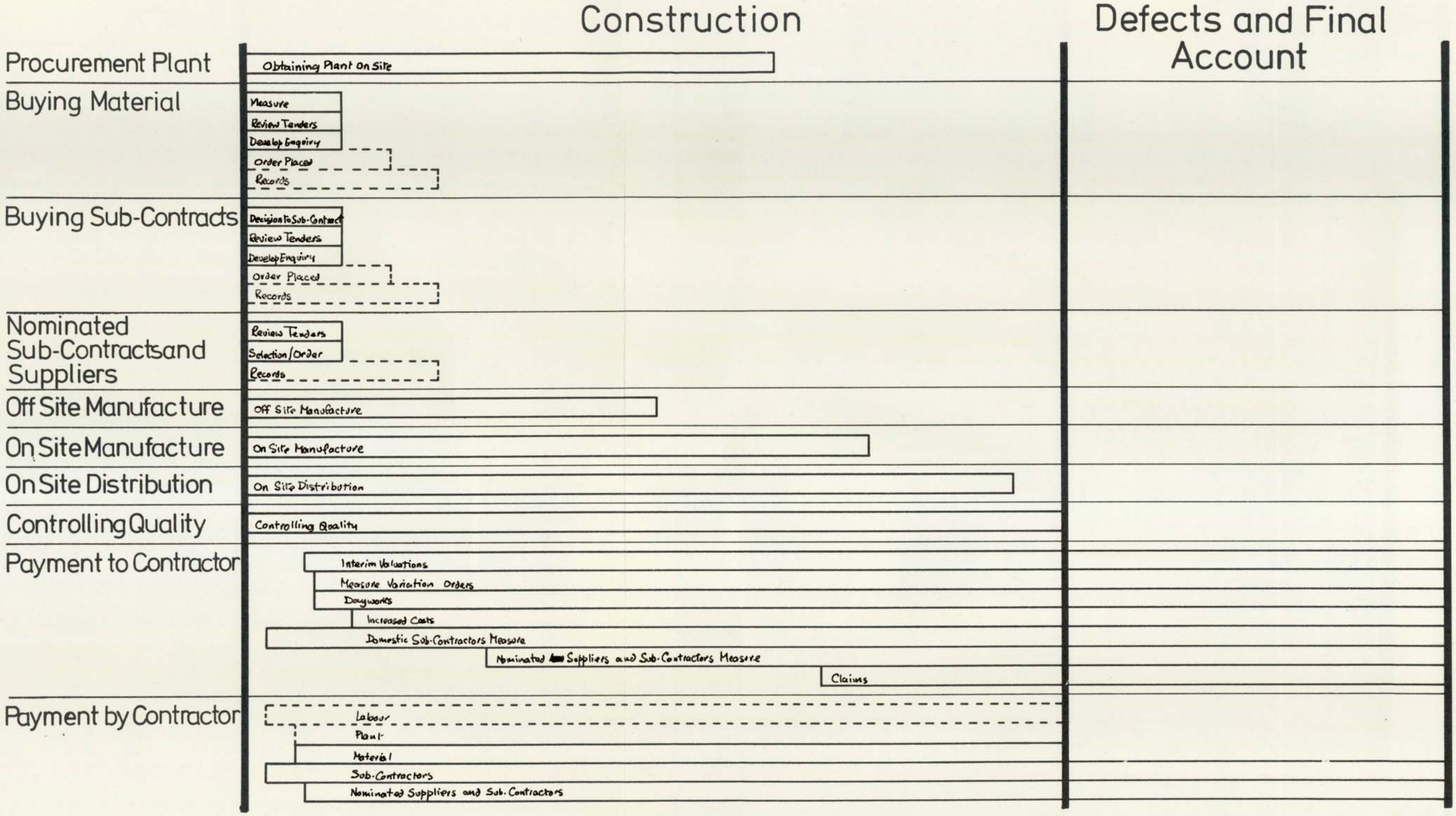

FIGURE 8

TASKS IN TIME SEQUENCE FOR CONSTRUCTION AND FINAL ACCOUNT PERIODS

CHAPTER VI

DATA MANIPULATION

6.1 The Scoring Rules

6.1.1 Combining Parameters of Sufficiency and Accuracy. The manipulation of continuously variable and highly subjective parameters of sufficiency and accuracy is a common occurrence in data analysis. In this particular instance the inherent errors contained within the subjective measurements are minimised by grouping the variables into only four classes. However, the combination of these two individual parameters of sufficiency and accuracy to give a single score requires critical inspection of the relative input-output values.

A procedure for processing these two factors must be capable of producing a score, from all reasonable combinations of the components, which does not lead to obvious discrepancies of relative order or magnitude when considered from a subjective viewpoint, i.e. all combinations giving identical score values must be observed and judged whether these may be prudently considered equivalent.

6.1.2 Scoring Rule One. A simple linear addition of sufficiency and accuracy provides a useful point of origin. Values of 2, 4, 6 and 8 points were allotted to each of the two

scales, see Figure 9. The highest sufficiency combined with the highest accuracy naturally gives the maximum possible score. Two intermediate scores give approximately half this value, whereas the most insufficient and inaccurate scores provide, when subjectively considered, an inflated value. Furthermore, the total linear shift of all values by a base of four does not commend itself since the relative percentage variations of combined scores will vary significantly. The number of possible increments in this scoring rule plotted against value, see Figure10, shows the distribution obtained.

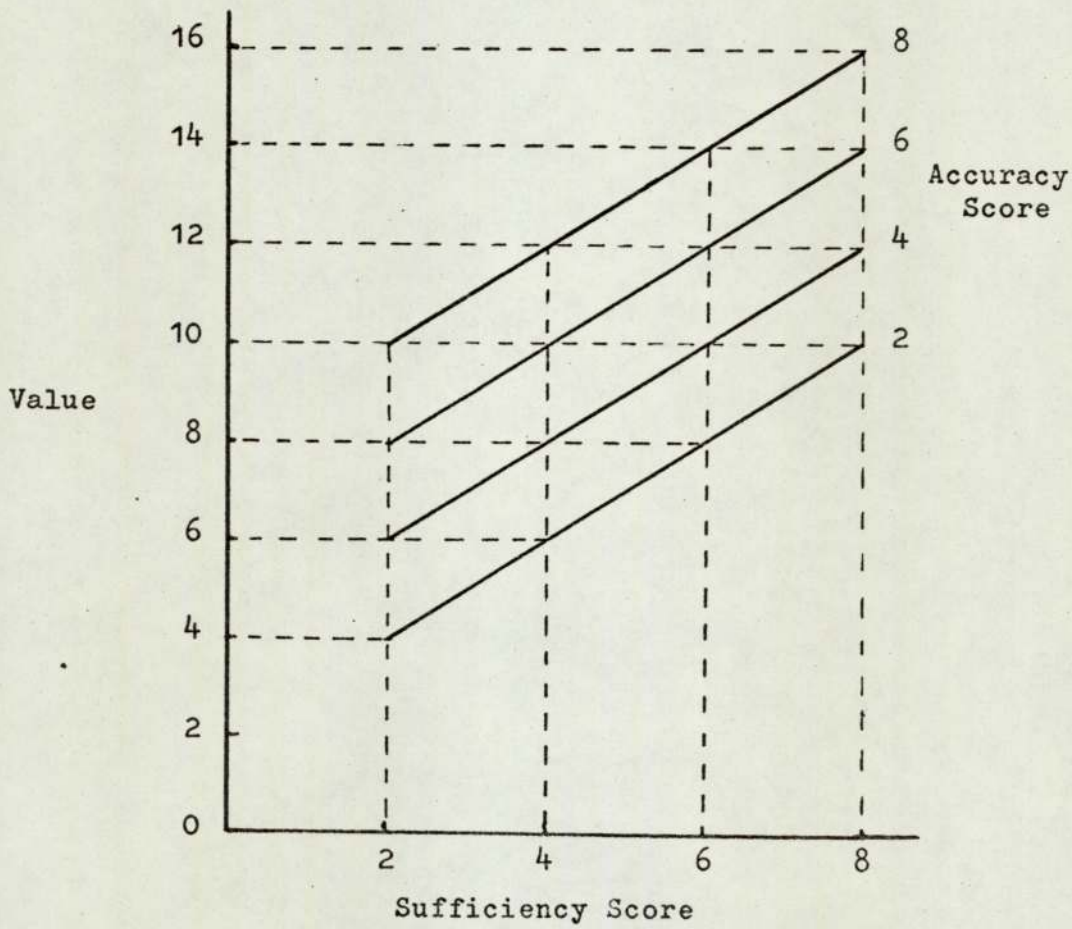

FIGURE 9

SCORING RULE ONE

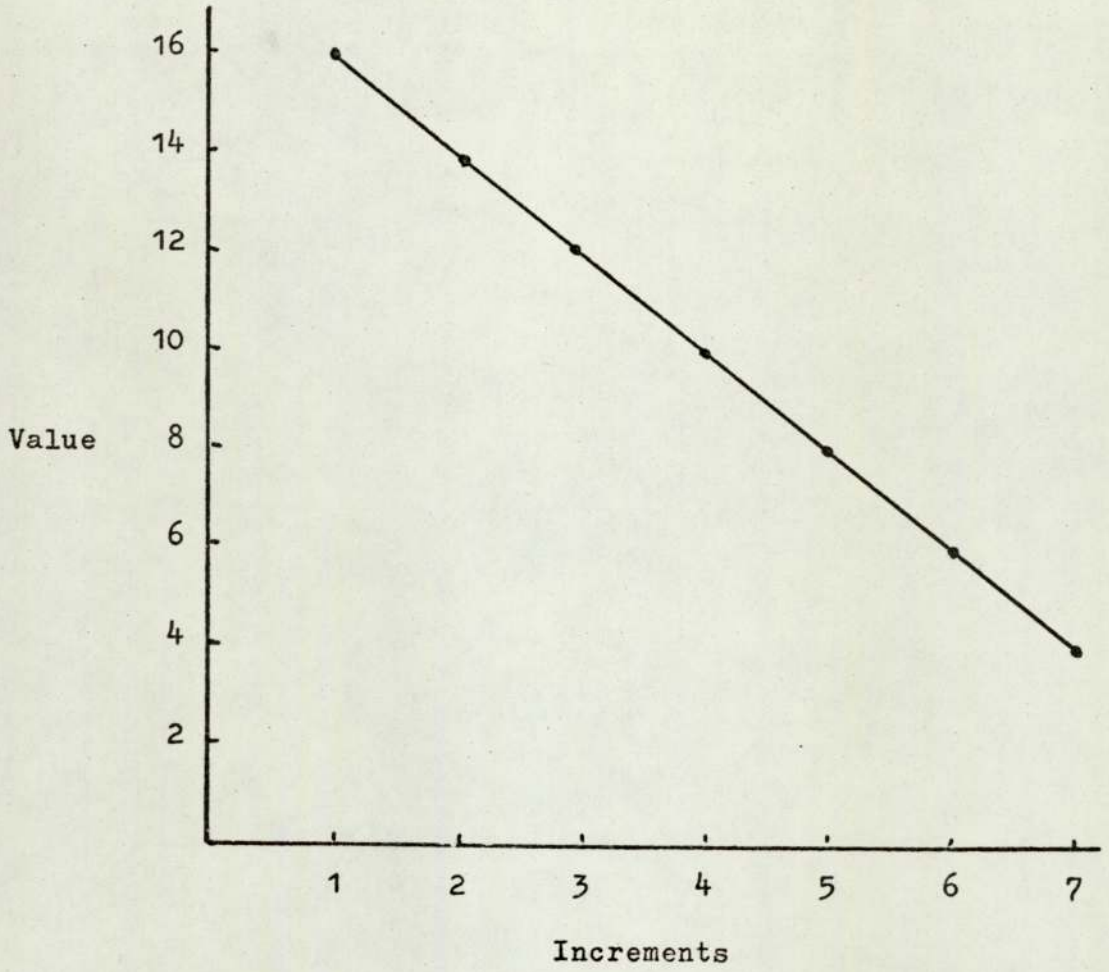

FIGURE 10

DISTRIBUTION CURVE RULE ONE

6.1.3 Scoring Rule Two. A modification of the first scoring rule was considered in which the value of the most insufficient and inaccurate scores were calculated and artificially suppressed to a zero value, see Figure 11.

This was in many ways a more satisfactory rule and indicated that the escalation of values for higher levels of sufficiency and accuracy would provide the basis from which a more satisfactory rule should emerge. However, despite the fact that

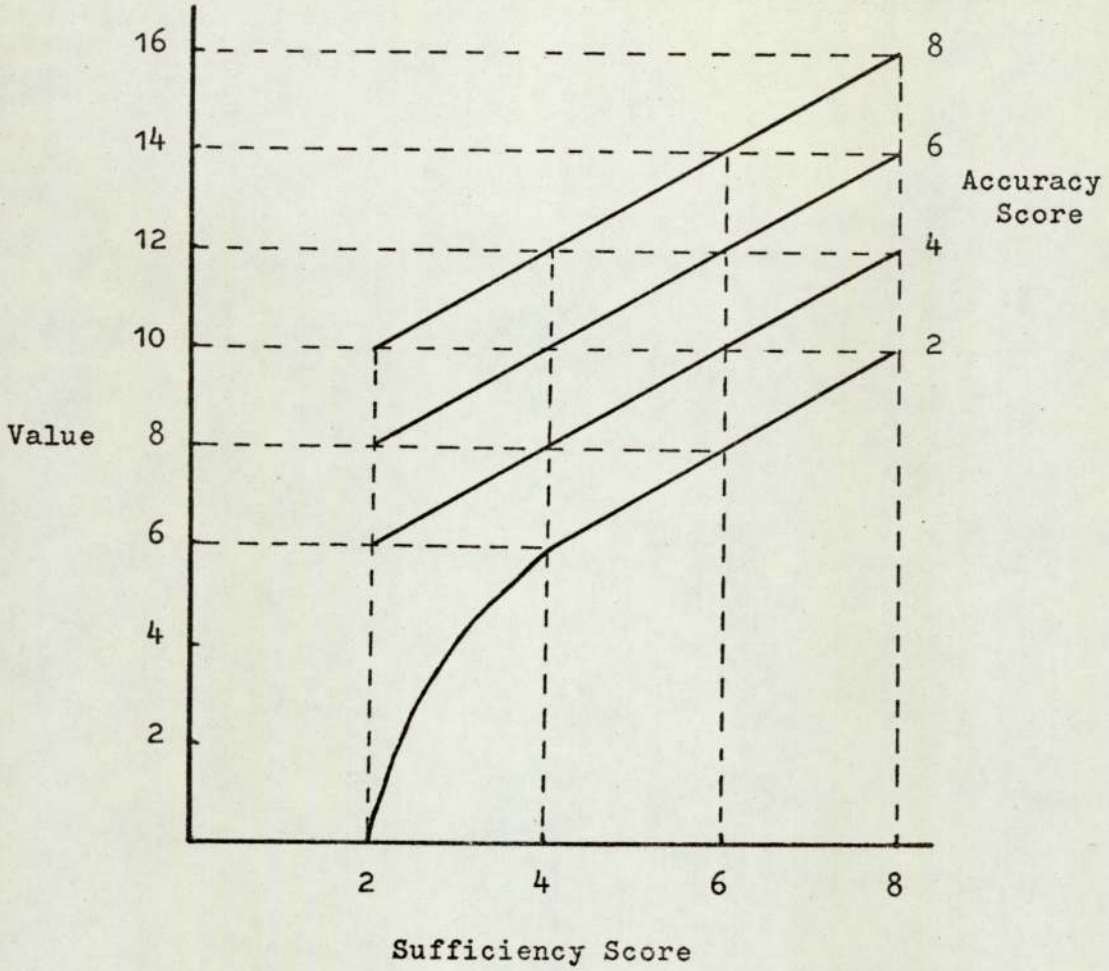

FIGURE 11

SCORING RULE TWO

the scale of values in this scoring rule now extended from 0 to 16 points, the effect, other than on the most insufficient/inaccurate combination, was to produce a linear shift of all values by a base of six. The distribution curve for rule two is shown in Figure 12.

In considering a variety of equal values one had to question whether such combinations really were of equal value, and thus whether the slope of the curve was sufficiently severe. A curve of a more exponential type which favoured higher scores seemed advantageous.

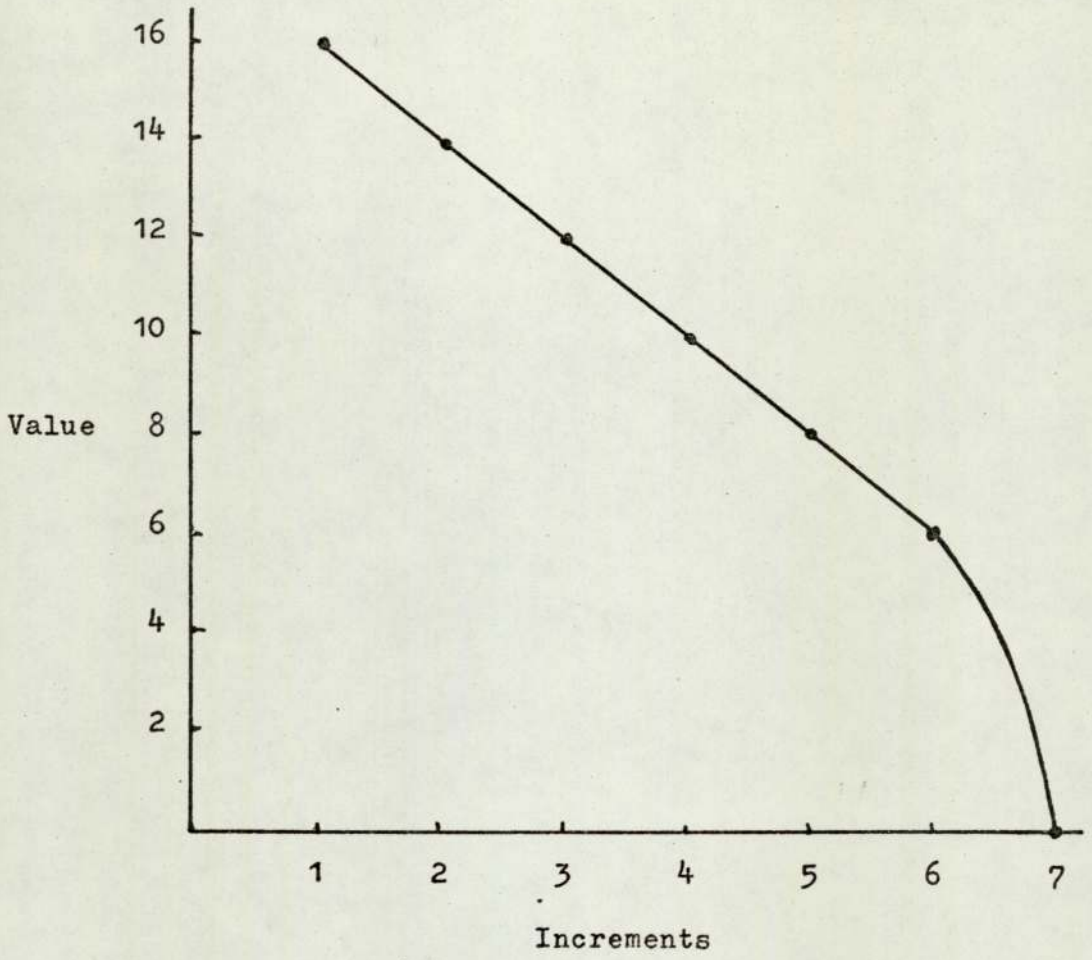

FIGURE 12

DISTRIBUTION CURVE RULE TWO

6.1.4 Scoring Rule Three. Since a scale with only four points is being considered a multiplication rule would result in preference for combinations of higher scores. The development of scoring rule two, that zero values may be recorded on the scale, was incorporated in such a way as to avoid any linear shift. The scores of 0, 1, 2 and 3 were used see Figure13.

The result was promising in that a number of "typical cases" rearranged subjectively closely corresponded to the order given by the scoring rule. This rule clearly gave an

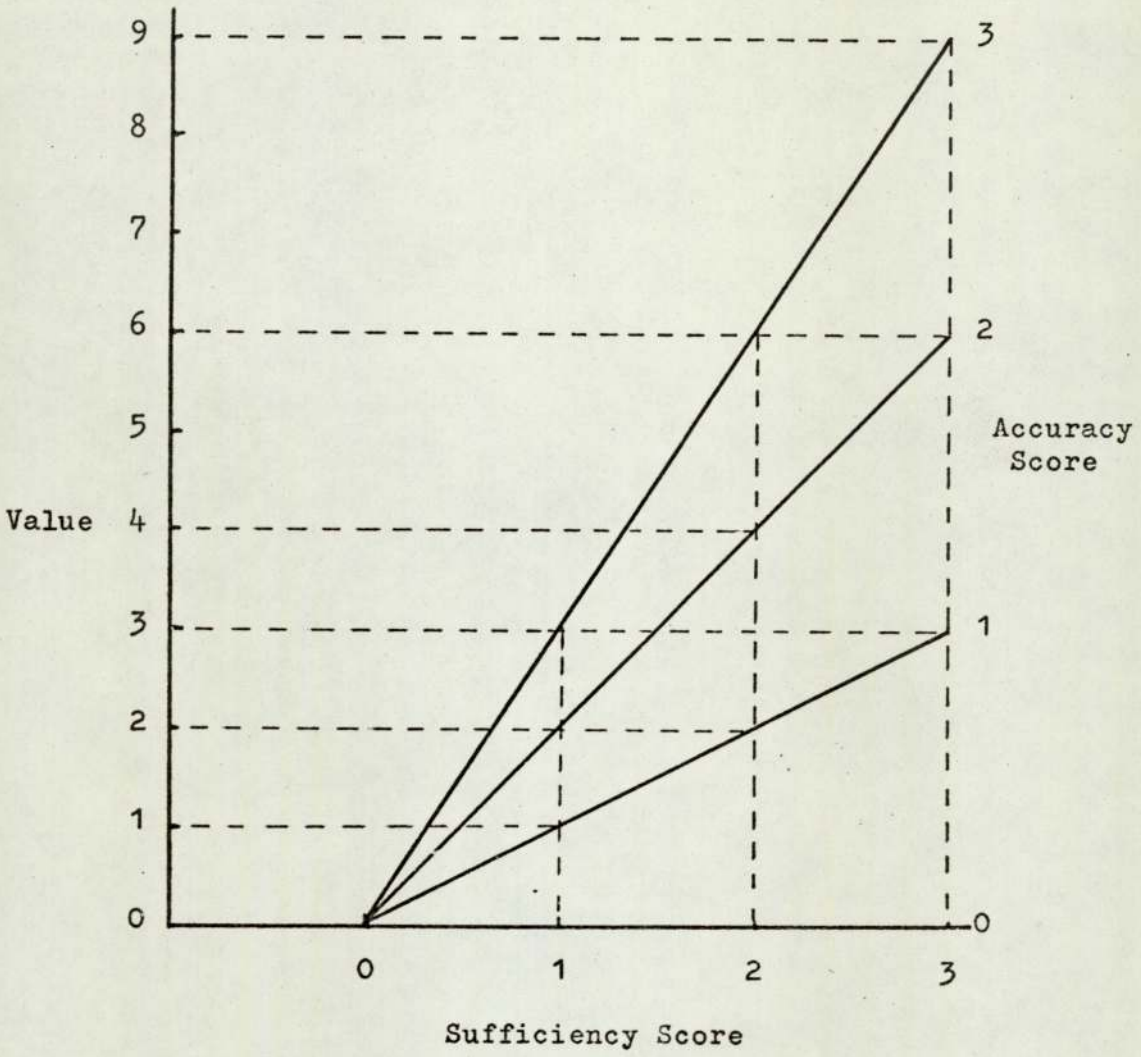

FIGURE 13

SCORING RULE THREE

exponential type distribution of values, however, by incorporating the score of '0' to avoid linear shift in the values, each score when multiplied with '0' results in a zero value. The distribution curve is shown in Figure 14.

Subjectively this was unacceptable since a highly sufficient/totally inaccurate combination would be more valuable than a totally insufficient/totally inaccurate combination. It was therefore necessary to retain the exponential type distribution and at the same time identify a value for combinations

inclusive of the lowest score.

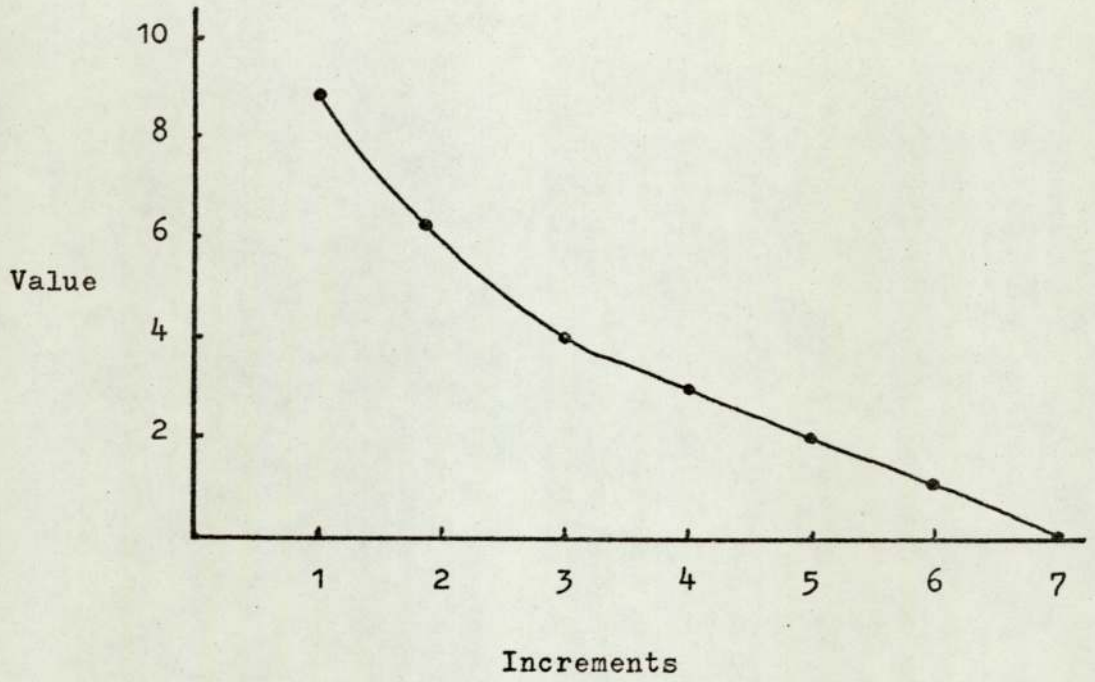

FIGURE 14

DISTRIBUTION CURVE RULE THREE

6.1.5 Scoring Rule Four Since the score of '0' could not be used acceptably with a multiplication rule, the scores were revised to 1, 2, 3 and 4. A linear shift of one on all values was unavoidable, but yet was sufficiently small to be acceptable, see Figure 15. The advantages of this rule over the third rule were a significantly greater maximum value, and an increased spread. Also this scoring rule contained more possible values than any of the rules previously considered. The combination of the two best scores produced the highest value of 16, while the product of two intermediate scores, say 2 and 3 resulted in a value considerably less than 50% of the

maximum. Further, with the single exception of the value 4, every combination produced a different value. The distribution curve of rule four is shown in Figure 16, (Page 54).

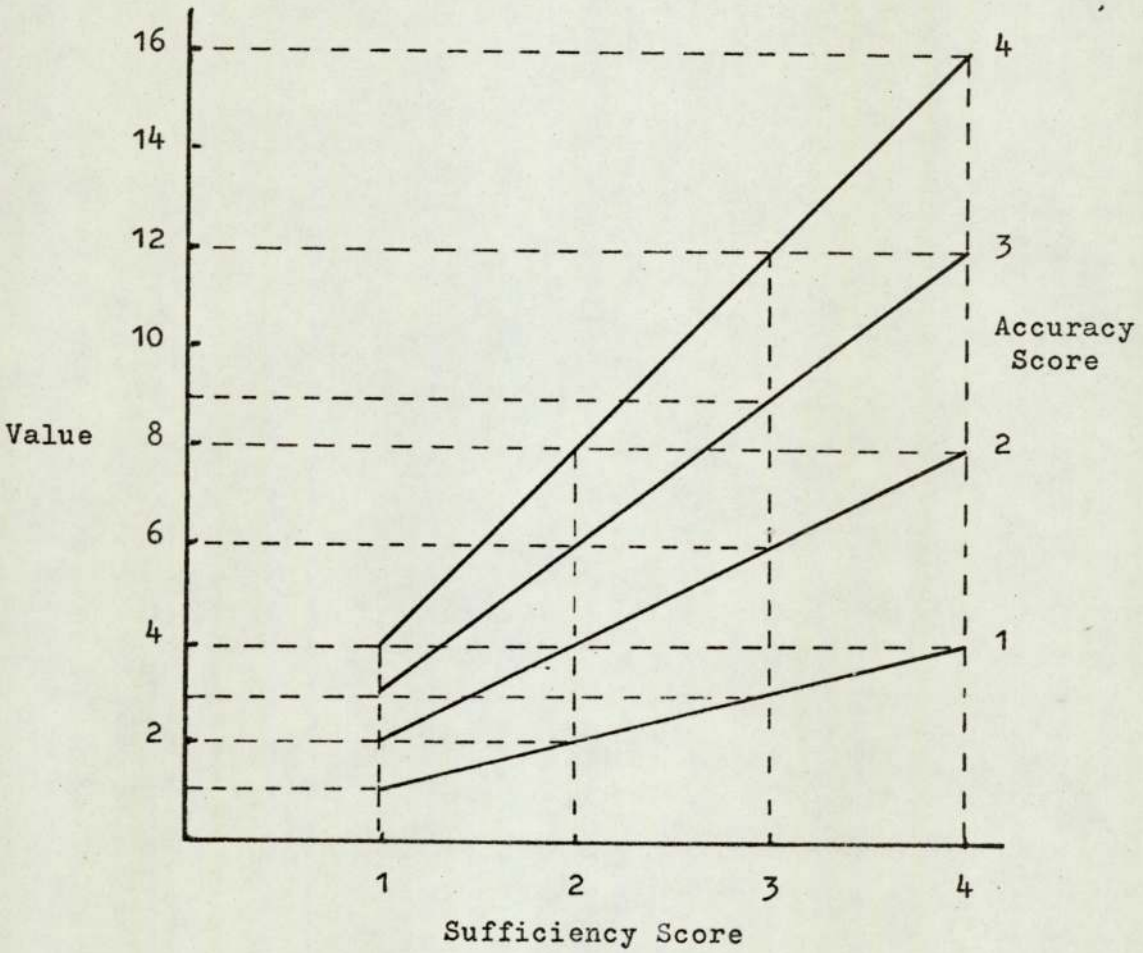

FIGURE 15

SCORING RULE FOUR

Using the facility of the computer it was possible to conduct an extensive examination of the overall effect of each scoring rule. The conclusions drawn confirmed that Rule 4 was indeed the most satisfactory method.

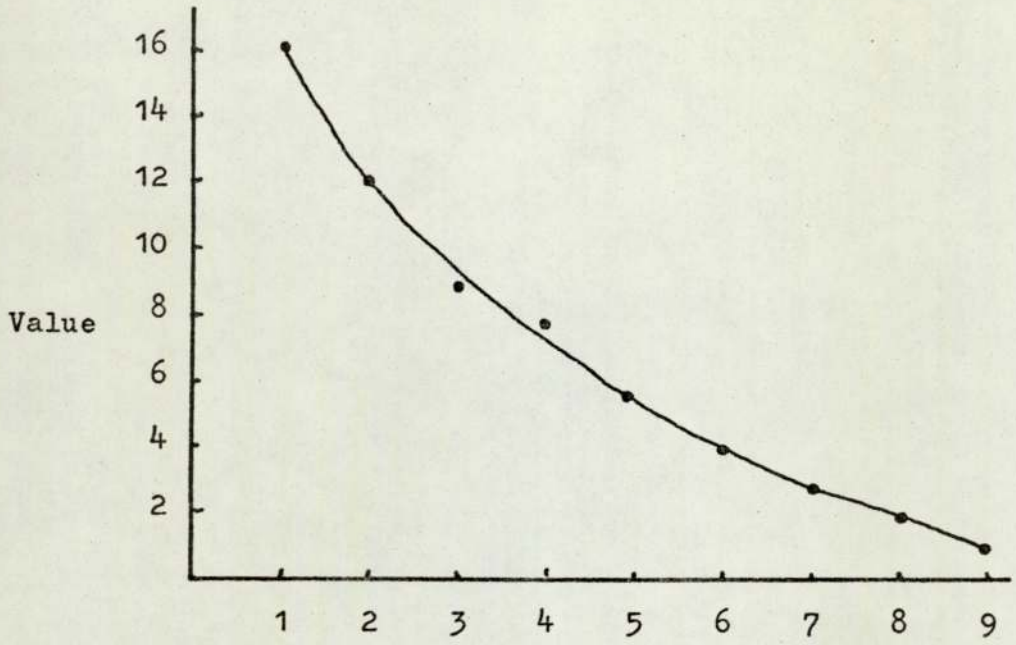

FIGURE 16

DISTRIBUTION CURVE RULE FOUR

6.2 The Computer Programme

A computer programme was written in the Algol language which was capable of facilitating outputs of information values and uses for each information package, task and procedure, and of analysing these into four classifications, namely, information packages 1 - 8, 9 - 12, 13 - 23 and 24 - 27 for each task and procedure. The basic data of use, sufficiency/accuracy selection and score values required three identical arrays with a total core space of 13,608 storage positions, see Figure 17.

Two further major arrays were also necessary, one for storing the vertical manipulations, and the other for storing the horizontal, which together increased the core space by a

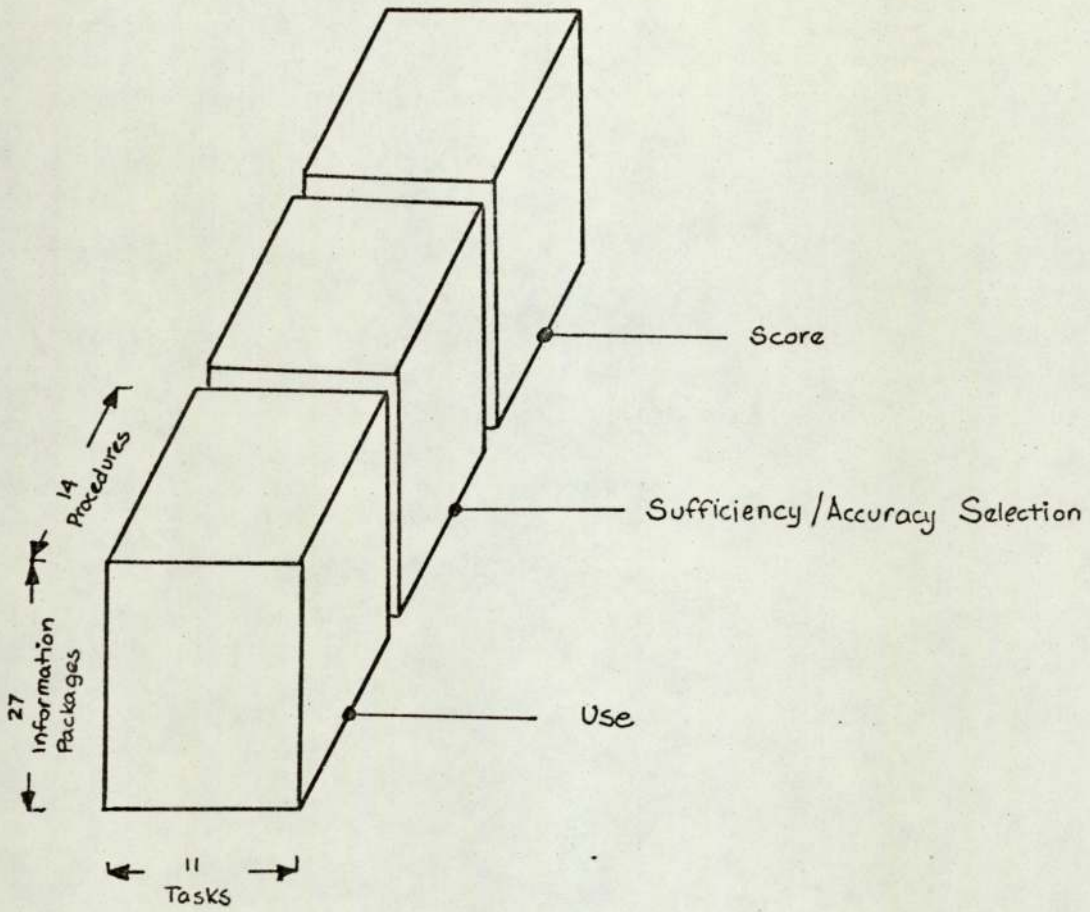

FIGURE 17

BASIC DATA ARRAYS

further 12,558, see Figure 18, (Page 56).

The programme itself added a further 8,000 positions, bringing the core space requirement well in excess of 32,000. This was significant since graph plotter procedures, extensively used in this programme, do not operate when the core space exceeds this figure. The five arrays were replanned and grouped as shown in Figure 19, (Page 57).

The three basic data arrays were condensed into one array by storing three pieces of information at each point, therefore

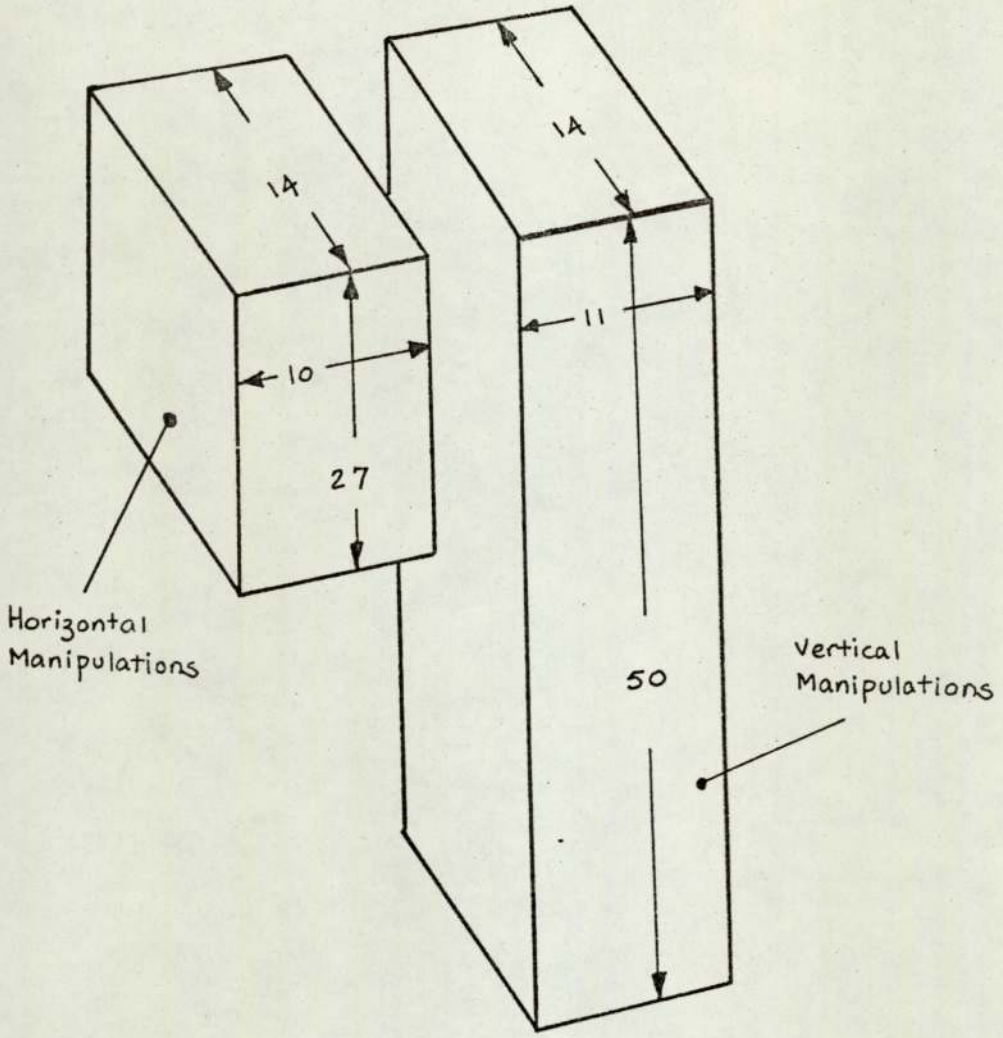

FIGURE 18

ARRAYS FOR HORIZONTAL AND

VERTICAL MANIPULATIONS

effecting a reduction of core space to bring the total below 32,000. In addition to the two three-dimensional arrays, a number of two-dimensional arrays were also necessary to

calculate values for the graph plotter procedures. An area of core space was used repeatedly for the two-dimensional arrays since their values were only graphed and not stored.

A sample of the computer analysis printout is contained in Appendix G.

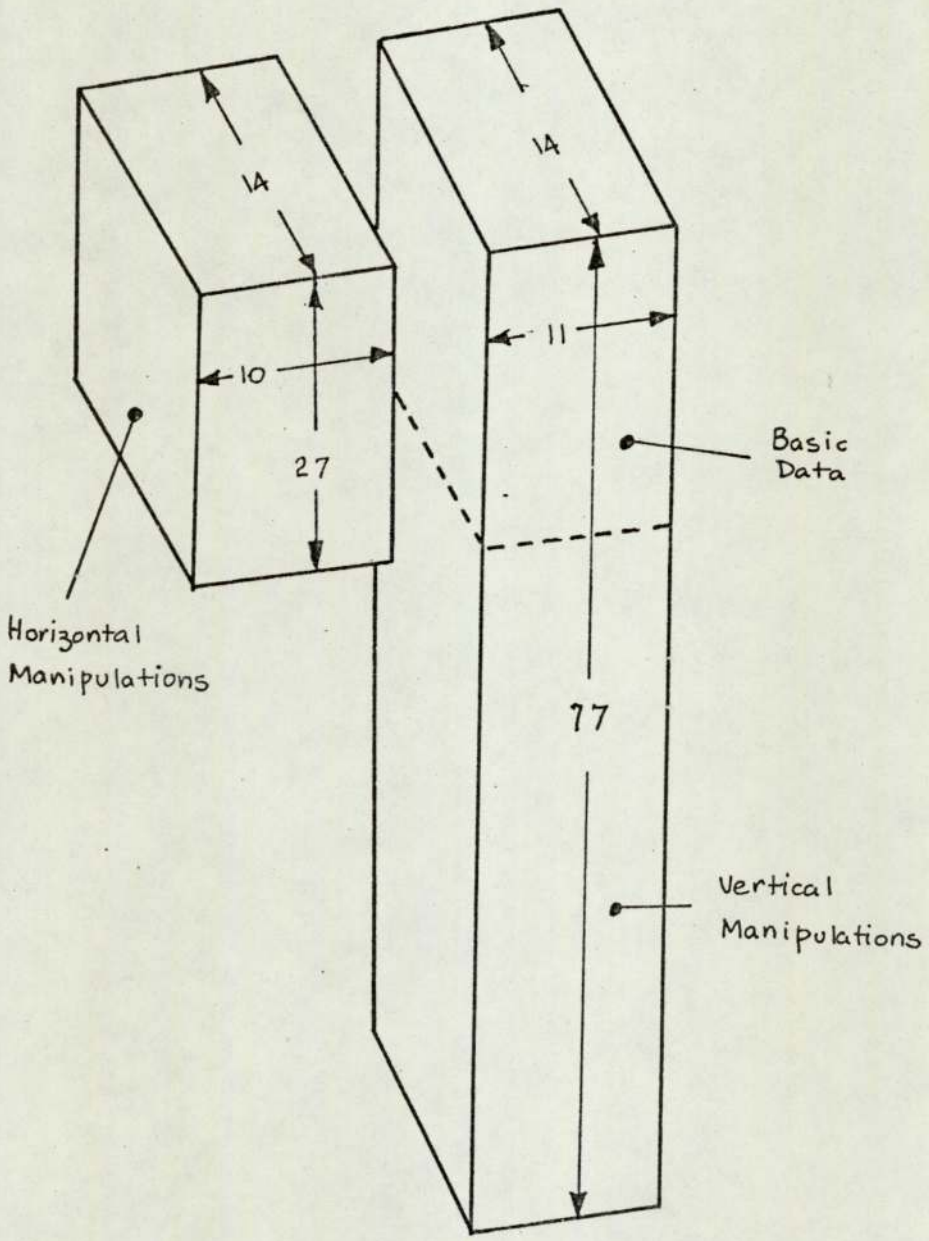

FIGURE 19

FINAL ARRANGEMENT OF ARRAYS

CHAPTER VII

STATEMENT OF RESULTS

7.1 Procedure 1 - Tender Estimating Planning

Six tasks were identified in Procedure 1, producing a possible 162 (6 X 27) uses of information. The actual number of information packages referred to was 98, a percentage of 60.5% as shown in Figure 20. The ninety-eight actual uses could, if each obtained a maximum value, produce a total value of 1,568 (98 X 16), however, the actual value achieved was 1,192, a percentage of 76% as shown in Figure 20.

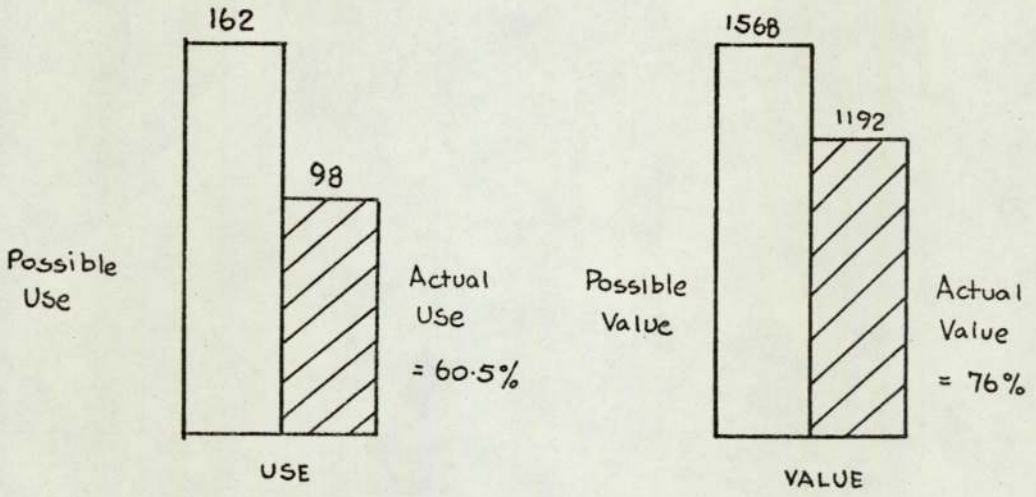

FIGURE 20

ACTUAL USE AND VALUE FOR PROCEDURE 1

The two factors of sufficiency and accuracy contribute* to the value of 1,192 in the approximate ratio of 45% sufficiency and 55% accuracy.

The actual use, expressed as a percentage of possible use, and the actual value, expressed as a percentage of possible value, are shown in Figure 21 for each task in this procedure.

Task	Percentage Use	Percentage Value
1	59%	81%
2	67%	81%
3	67%	78%
4	33%	78%
5	70%	80%
6	67%	60%

FIGURE 21

PERCENTAGE OF ACTUAL USE AND VALUE

FOR TASKS IN PROCEDURE 1

Task 4, Nominated Sub-Contractors, used significantly less information than the other tasks, and had the effect of lowering the average percentage use for the procedure by 5.5%.

---

* The approximate contribution of S to the product S X A is defined as:-

$$\frac{S}{S + A} \times SA$$

However, despite the wide fluctuation in use from task to task, the percentage values of information, with the exception of task 6, lie within a variation of plus or minus 1.5% of 79.5%.

Although the percentage value of the information used in task 6 is approximately 20% lower than other tasks, the contribution of sufficiency and accuracy remains in the same ratio as that for the total procedure, indicating a general decline in information value, rather than a deterioration of a single aspect.

Figure 22 shows the use of the bill of quantities analysed by information package into use, use expressed as a percentage of possible use, and the value expressed as a percentage of possible value. The use made of the information packages varied from 0% to 100%. 85% of the available information was used in this procedure, and three out of every four packages used exceeded the average percentage use for the procedure. The percentage values of the information used, however, were more uniform, since only two packages fell more than 10% below the average percentage value of 76%.

7.2 Procedure 2 - Tender Estimating Pricing

Seven tasks were identified, resulting in a possible 189 uses of information. The actual use and value of the information used in this procedure are shown in Figure 23 (Page 62).

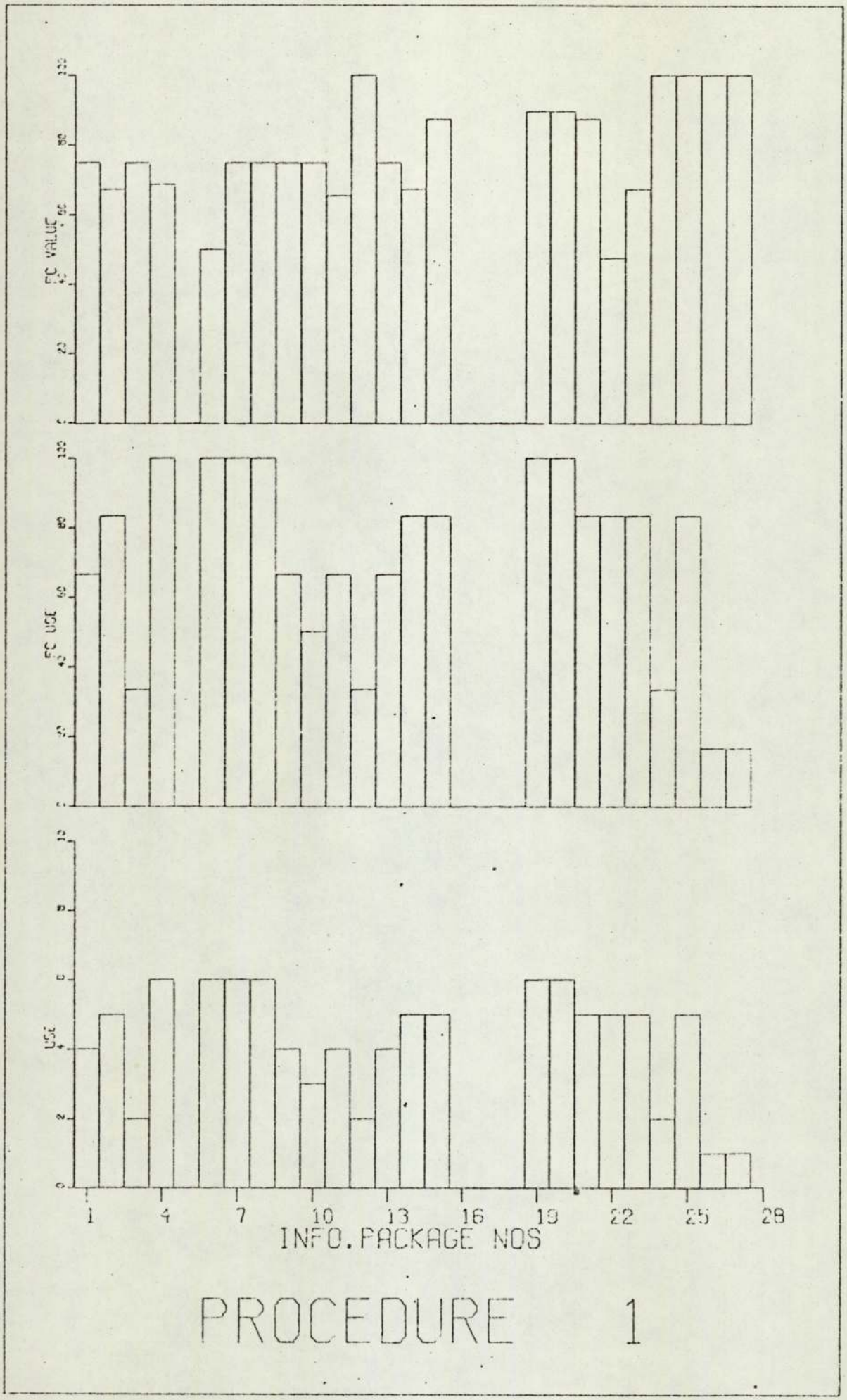

FIGURE 22

INFORMATION PACKAGES USED IN PROCEDURE 1

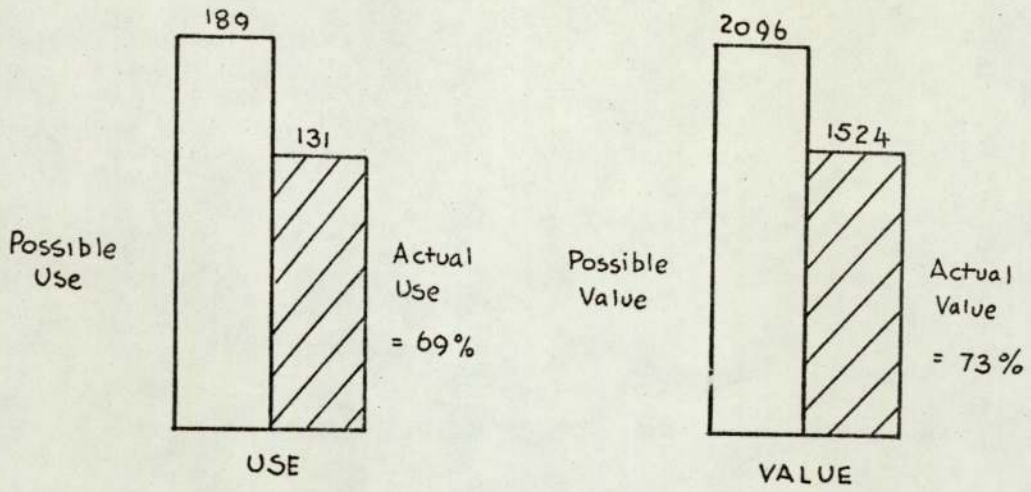

FIGURE 23

ACTUAL USE AND VALUE FOR PROCEDURE 2

The two factors of sufficiency and accuracy contribute to the value of 1,524 in the approximate ratio of 45% sufficiency and 55% accuracy.

The actual use, expressed as a percentage of possible use, and the actual value, expressed as a percentage of possible value, are shown in Figure 24 for each task in this procedure.

The low percentage use in task 4 has the effect of lowering the average percentage use for the procedure by 6%.

With the exception of tasks 6 and 7, all other percentage values lie within a variation plus or minus 4% of 80%. The contribution of sufficiency and accuracy in tasks 6 and 7 are in the same ratio as they are in the average percentage value for the procedure, indicating an overall decline in information value.

Task	Percentage Use	Percentage Value
1	59%	84%
2	70%	76%
3	67%	78%
4	37%	83%
5	70%	83%
6	85%	58%
7	96%	61%

FIGURE 24

PERCENTAGE OF ACTUAL USE AND VALUE

FOR TASKS IN PROCEDURE 2

The analysis by information package in Figure 25 (Page 64), shows that all the information contained in the bill of quantities was used in this procedure. The average percentage of use for the preliminary section of the bill was 89%, 20% above the average for the procedure, while the average for the remainder of the bill was 61%, 8% below the average for the procedure.

The percentage values of the information used ranges from 40% to 100%. The average percentage value for the preliminaries section of the bill of quantities was 74%, the preambles section 68%, the measured work section 62% and the prime cost and provisional sum section 100%.

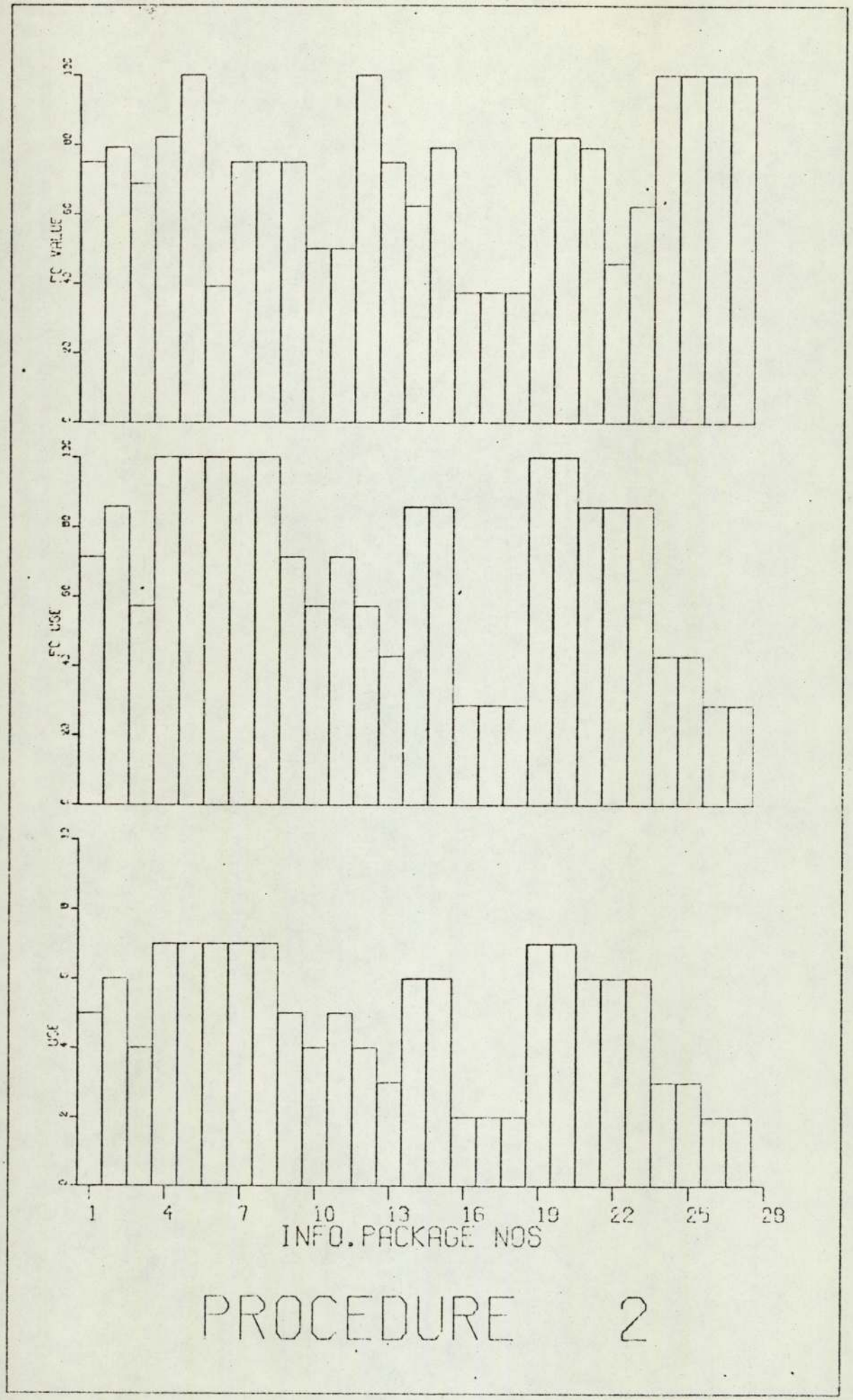

FIGURE 25

INFORMATION PACKAGES USED IN PROCEDURE 2

7.3 Procedure 3 - Production Planning (Strategic)

Nine tasks were identified in this procedure making possible 243 uses of information. The actual use and value of the information used in the procedure are shown in Figure 26.

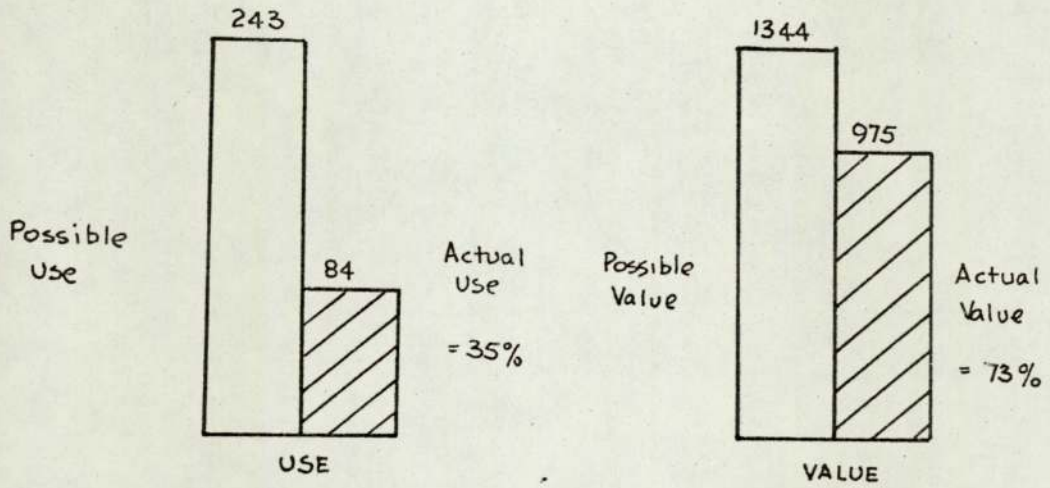

FIGURE 26

ACTUAL USE AND VALUE FOR PROCEDURE 3

The factors of sufficiency and accuracy contribute to the value of 975 in the approximate ratio of 49% sufficiency and 51% accuracy. Figure 27 shows the actual use and value of information for each task expressed as a percentage of possible use and a percentage of possible value.

Although the average percentage of use in this procedure was low, 35%, it is not truly representative, since the average percentage use for 75% of the information was only 18.5% and the average for the remainder 90.5%. The bill was clearly very well used for task 4, Planning Construction Method, and task 7,

Task	Percentage Use	Percentage Value
1	11%	67%
2	11%	67%
3	4%	38%
4	85%	67%
5	19%	80%
6	7%	75%
7	96%	70%
8	48%	72%
9	30%	100%

FIGURE 27

PERCENTAGE OF ACTUAL USE AND VALUE

FOR TASKS IN PROCEDURE 3

Preparing the Approximate Programme. The percentage value of the information used in both these tasks, however, fell below the average percentage value for the procedure. In task 9, Insurances, only the information packages normally contained in the preliminary section of the bill was used, and as Figure 27 shows this information was excellent for the calculation of insurance liability.

Analysis by information package, see Figure 28, shows that the whole bill was used for strategic planning. Three

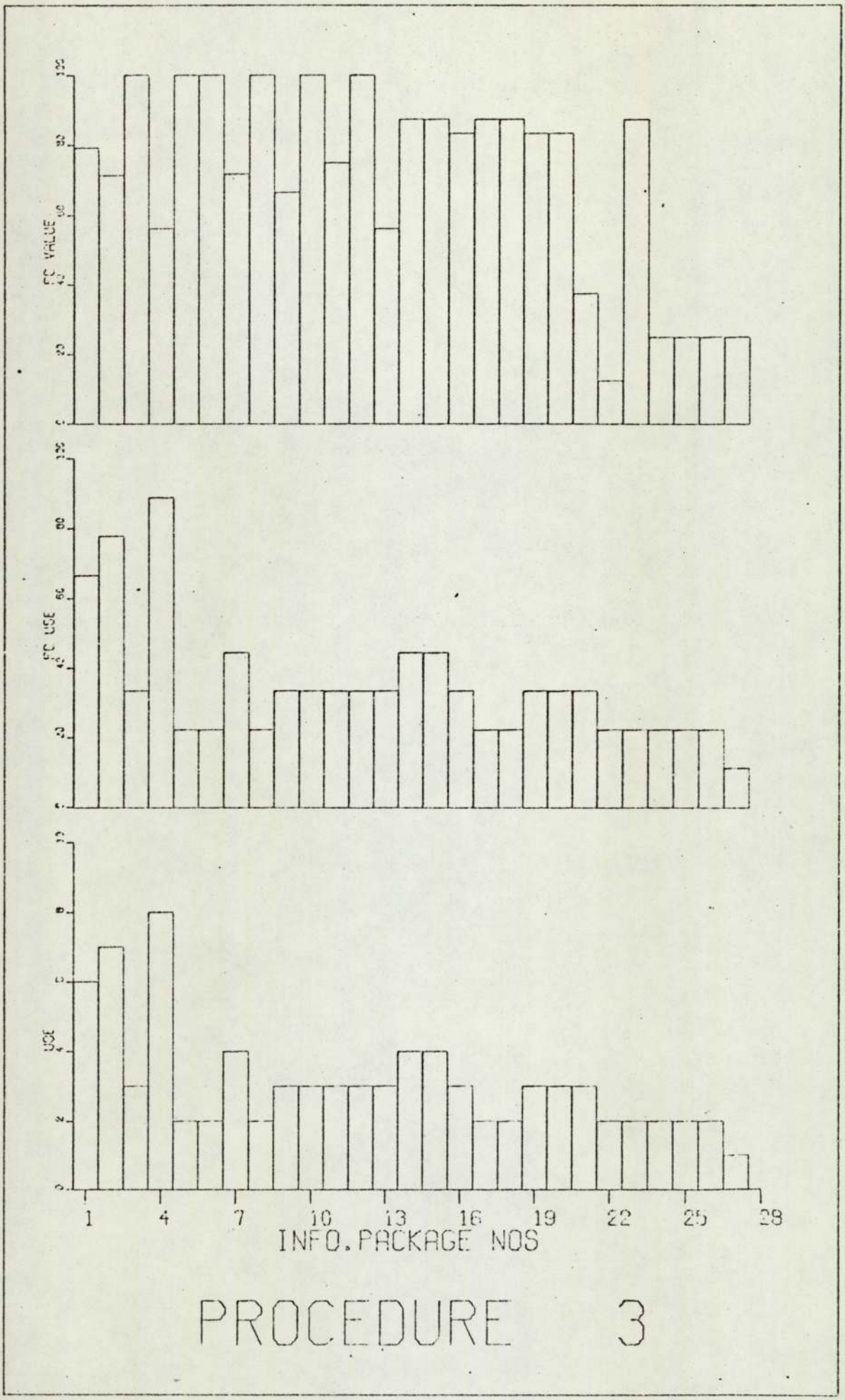

FIGURE 28

INFORMATION PACKAGES USED IN PROCEDURE 3

information packages, 1, Project Details, 2, Site and Location, and 4, Times and Phasing, were used notably more than the other packages, yet only the percentage value of package 1 exceeded the average percentage value for the procedure.

The percentage values of information fluctuated widely from 12% to 100%, yet the significantly low percentages may be directly attributed to information of a very provisional nature. The contribution of sufficiency and accuracy in the information packages 21, 22, 24, 25, 26 and 27 is approximately 72% sufficiency and 28% accuracy.

7.4 Procedure 4 - Production Planning (Tactical)

Three tasks were identified, resulting in a possible 81 uses of information. The actual use and value of the information used in this procedure are shown in Figure 29.

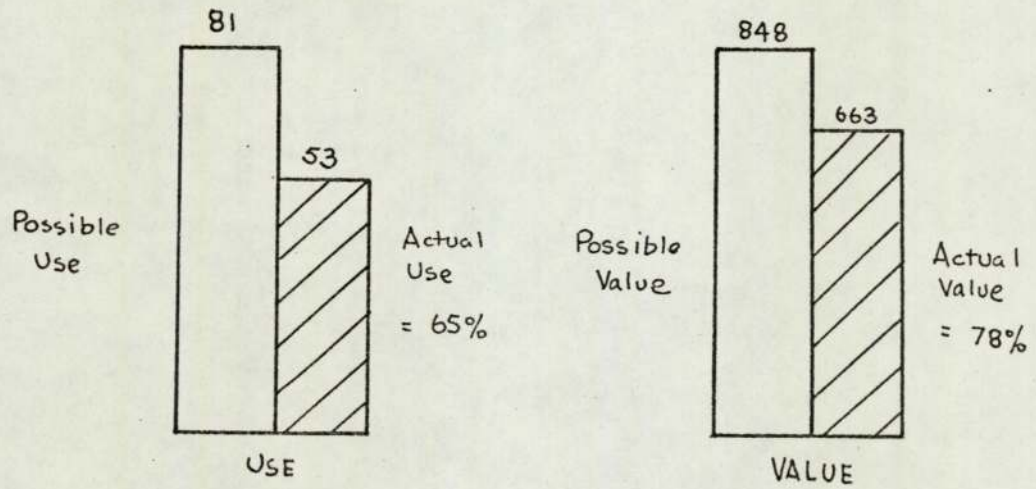

FIGURE 29

ACTUAL USE AND VALUE FOR PROCEDURE 4

The two factors of sufficiency and accuracy contribute to the value of 663 in the approximate ratio of 46% sufficiency and 54% accuracy.

The actual use, expressed as a percentage of possible use, and the actual value, expressed as a percentage of possible value, are shown in Figure 30 for the three tasks in this procedure.

Task	Percentage Use	Percentage Value
1	67%	76%
2	81%	76%
3	48%	84%

FIGURE 30

PERCENTAGE OF ACTUAL USE AND VALUE

FOR TASKS IN PROCEDURE 4

The analysis by information package, Figure 31 (Page 70), shows that package 7, Facilities and Services, and the provisional information contained in packages 24, 25, 26 and 27 were not used. Despite the fact that the number of tasks considered in procedure 4 was only a third of those considered in procedure 3, a strong correlation of percentage values exists between the two procedures, which is surprising considering the tasks in procedure 4 are of a totally different nature to those in procedure 3.

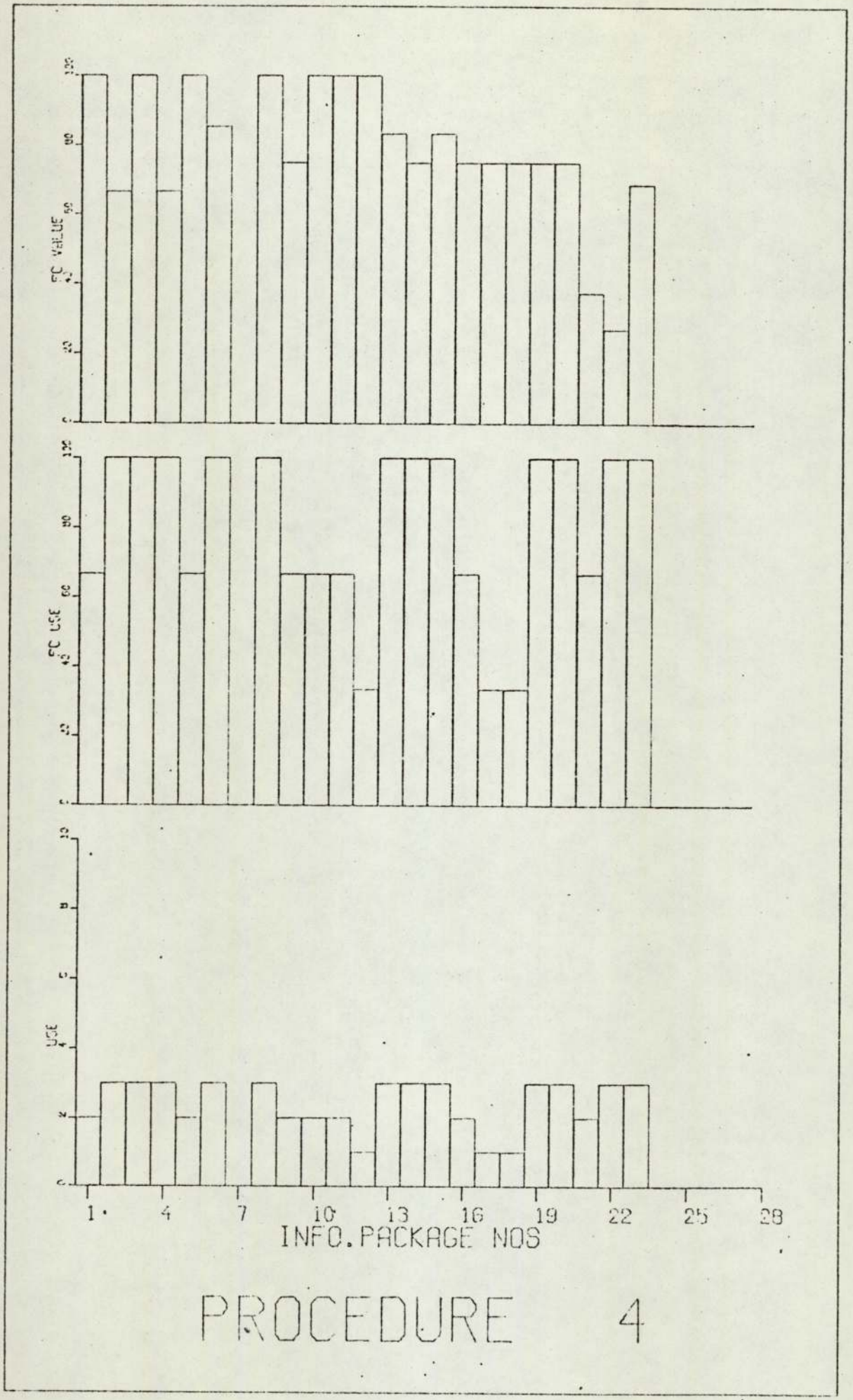

FIGURE 31

INFORMATION PACKAGES USED IN PROCEDURE 4

7.5 Procedure 5 - Production Procurement Plant

Two tasks were identified, resulting in a possible 54 uses of information. The actual use and value of the information used in this procedure are shown in Figure 32.

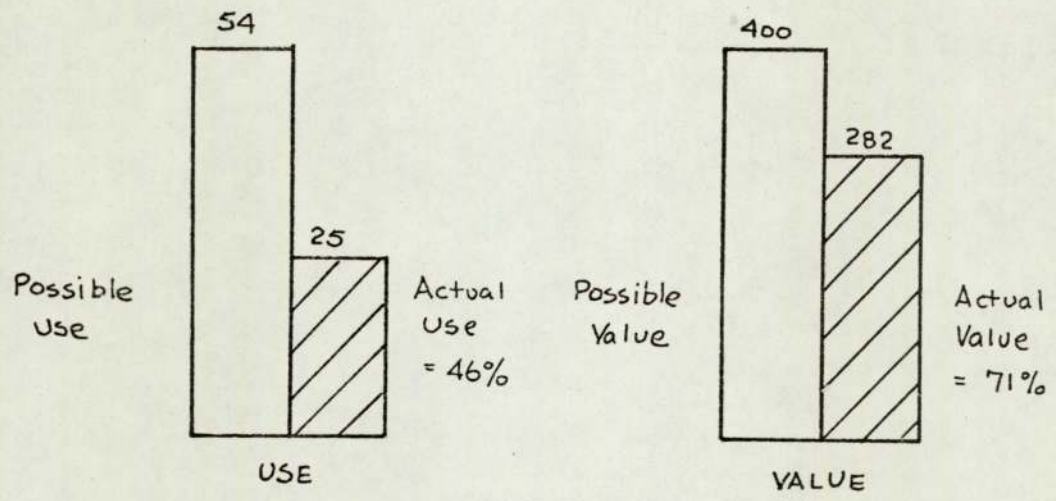

FIGURE 32

ACTUAL USE AND VALUE FOR PROCEDURE 5

The two factors of sufficiency and accuracy contribute to the value of 282 in the approximate ratio of 48% sufficiency and 52% accuracy. The actual use, expressed as a percentage of possible use, and the actual value, expressed as a percentage of possible value, are shown in Figure 33 (Page 72) for the two tasks in procedure 5.

Task 2, Obtaining Plant on Site, uses less than half the number of information packages used in task 1, Select Major Plant, also the value of the information used in task 2 is

approximately 30% lower than that used in task 1. This difference is largely accounted for by the deterioration of information package 6, Statutory Details, from a value of 16 to a value of 1, and information packages 14 and 15, Work Quantities and Quantity Units, from a value of 12 to a value of 6.

Task	Percentage Use	Percentage Value
1	67%	76%
2	26%	55%

FIGURE 33

PERCENTAGE OF ACTUAL USE AND VALUE

FOR TASKS IN PROCEDURE 5

The analysis by information package, Figure 34 (Page 73), shows that 70% of the information contained in the bill of quantities was used in this procedure. The percentage values of information range from 6% to 100%, but show no correlation to the pattern of use.

The average percentage value for the preliminaries section of the bill of quantities was 73%, for the preamble section 100%, and the measured work section 51%.

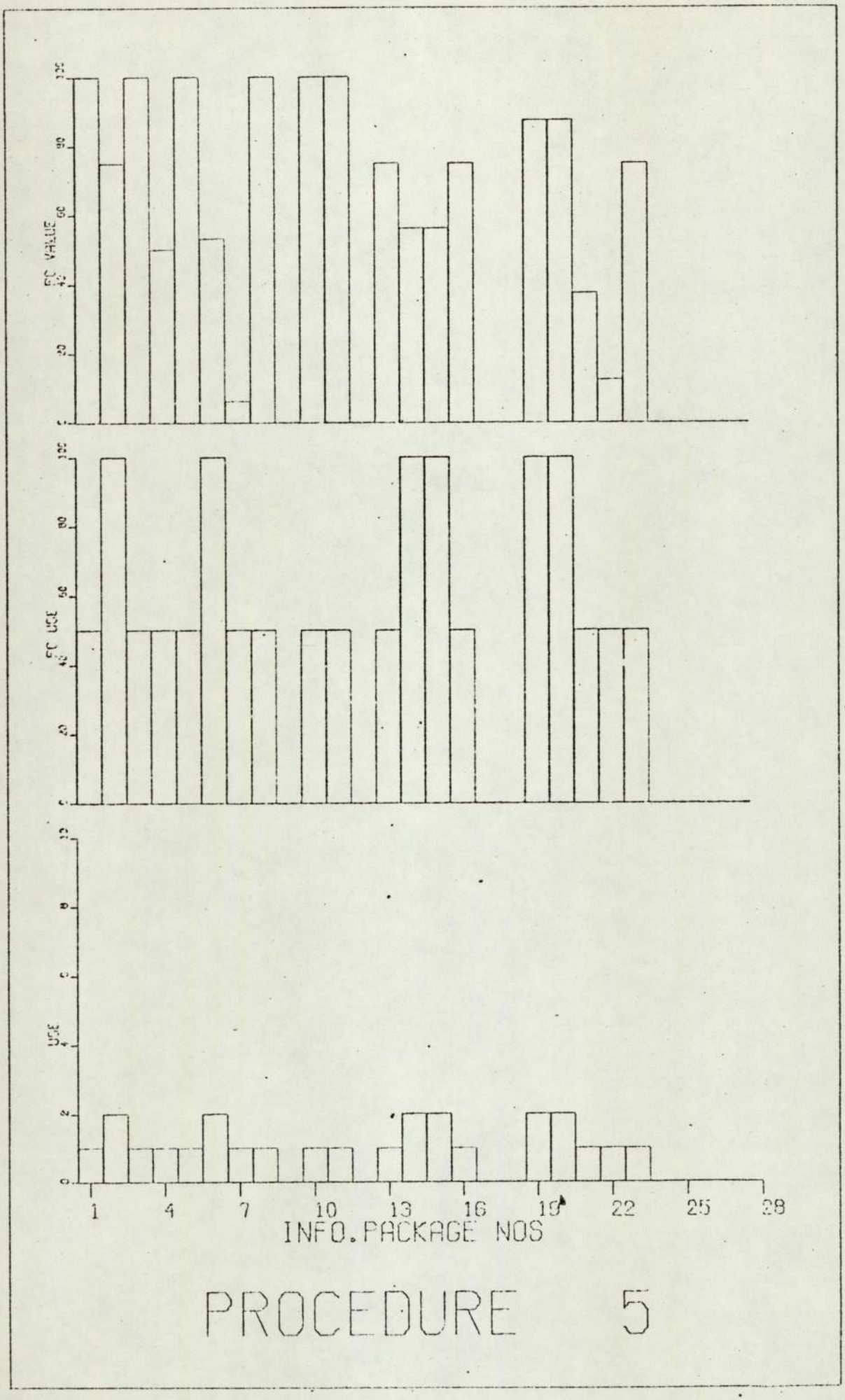

FIGURE 34

INFORMATION PACKAGES USED IN PROCEDURE 5

7.6 Procedure 6 - Production Procurement Materials

Three tasks were identified in procedure 6, making possible 81 uses of information. The actual use and value of the information used are shown in Figure 35.

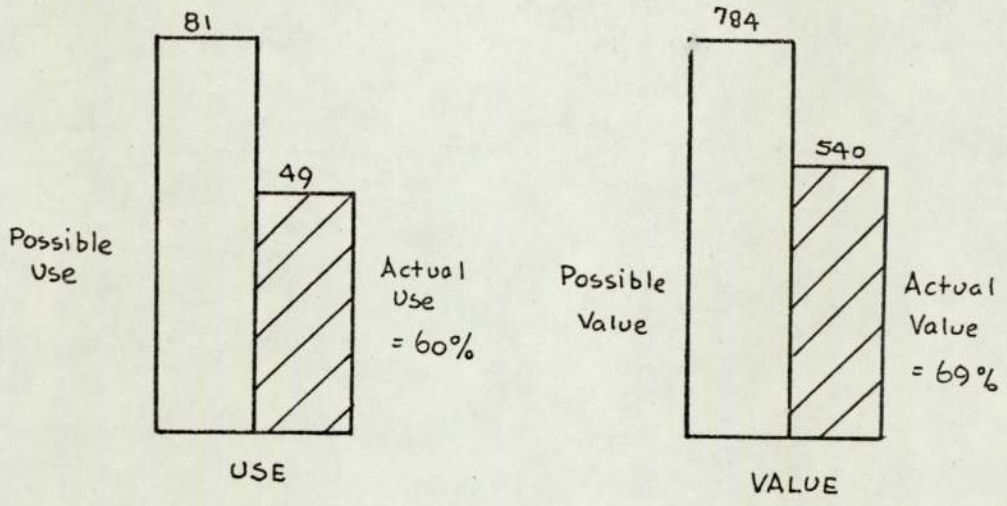

FIGURE 35

ACTUAL USE AND VALUE FOR PROCEDURE 6

The two factors of sufficiency and accuracy contribute to the value of 540 in the approximate ratio of 46% sufficiency and 54% accuracy.

Figure 36 (Page 75) shows the percentage use, and the percentage value of the information used in each task of procedure 6.

The analysis by information package, Figure 37 (Page 76), shows that 78% of the information packages were used for the

procurement of materials. The percentage values of information range from 25% to 100%.

Task	Percentage Use	Percentage Value
1	30%	94%
2	78%	69%
3	74%	59%

FIGURE 36

PERCENTAGE OF ACTUAL USE AND VALUE

FOR TASKS IN PROCEDURE 6

The average percentage value for the preliminaries section was 82%, for the preambles section 41%, and for the measured work section 69%.

7.7 Procedure 7 - Production Procurement Domestic Sub-Contractors

Three tasks were identified in this procedure, producing 81 possible references of information packages. Figure 38 (Page 77) shows the actual use recorded and the value of the information used to procure domestic sub-contractors.

The two factors of sufficiency and accuracy contribute to the value of 740 in the approximate ratio of 49% sufficiency and 51% accuracy.

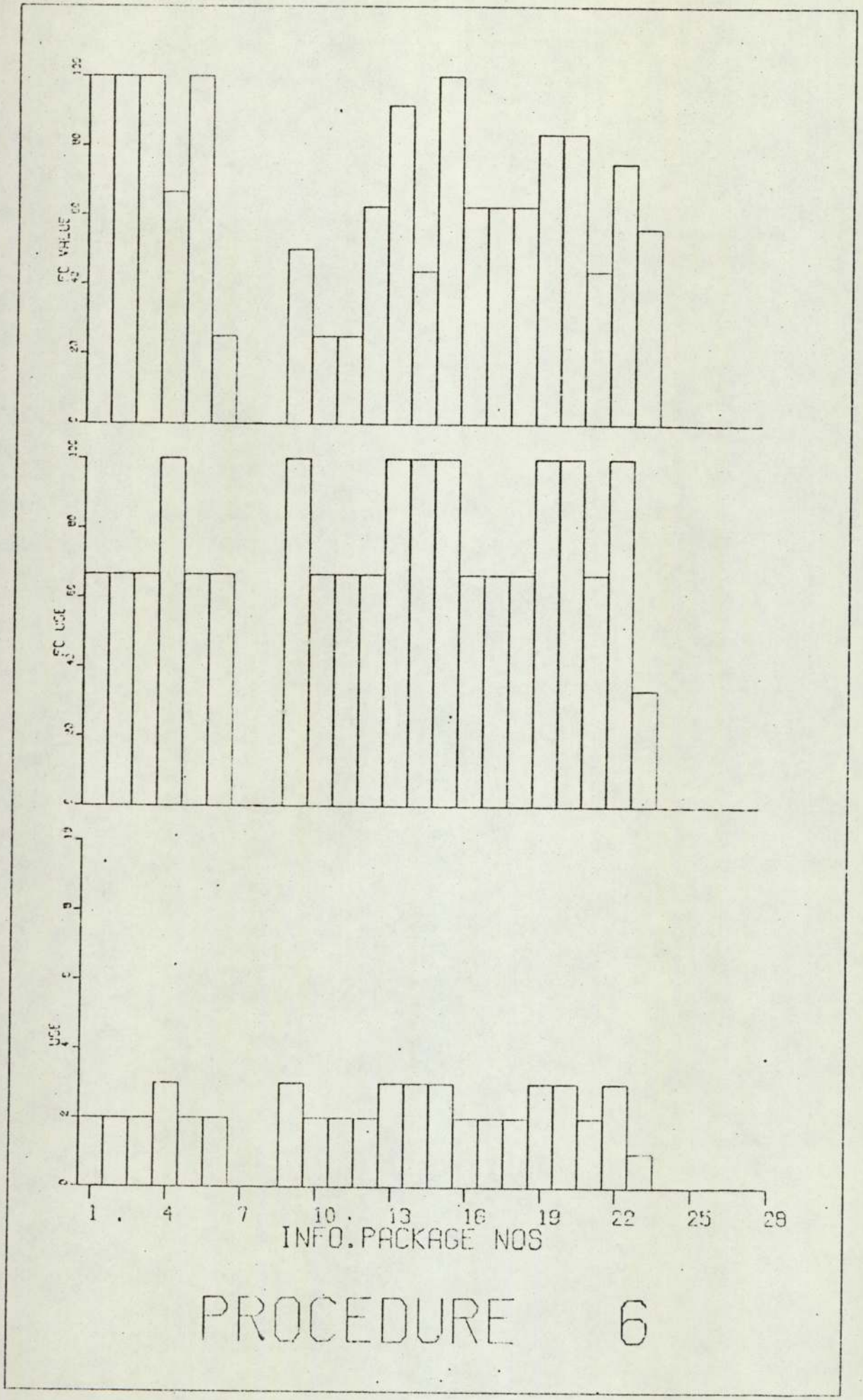

FIGURE 37

INFORMATION PACKAGES USED IN PROCEDURE 6

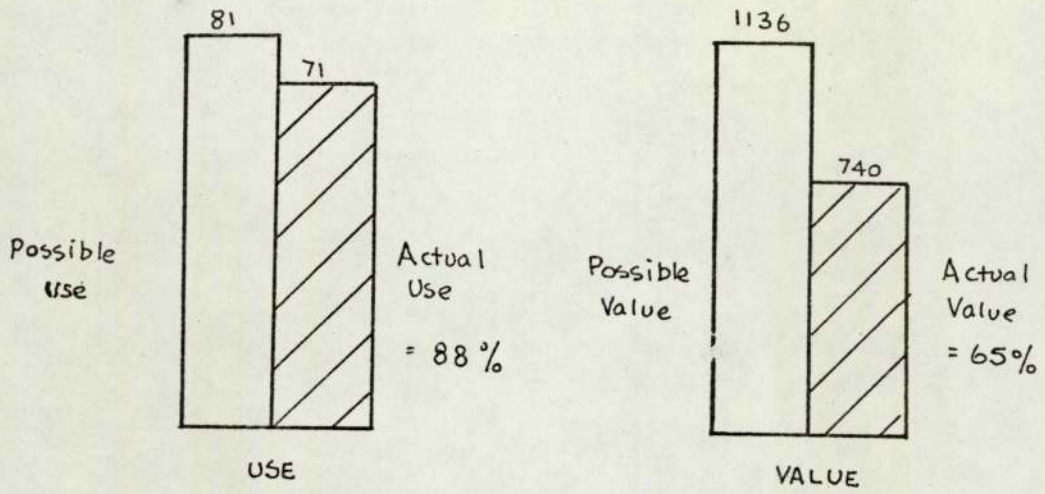

FIGURE 38

ACTUAL USE AND VALUE FOR PROCEDURE 7

Figure 39 shows the percentage use, and the percentage value of the information used in each task of procedure 7.

Task	Percentage Use	Percentage Value
1	93%	72%
2	85%	61%
3	85%	61%

FIGURE 39

PERCENTAGE OF ACTUAL USE AND VALUE

FOR TASKS IN PROCEDURE 7

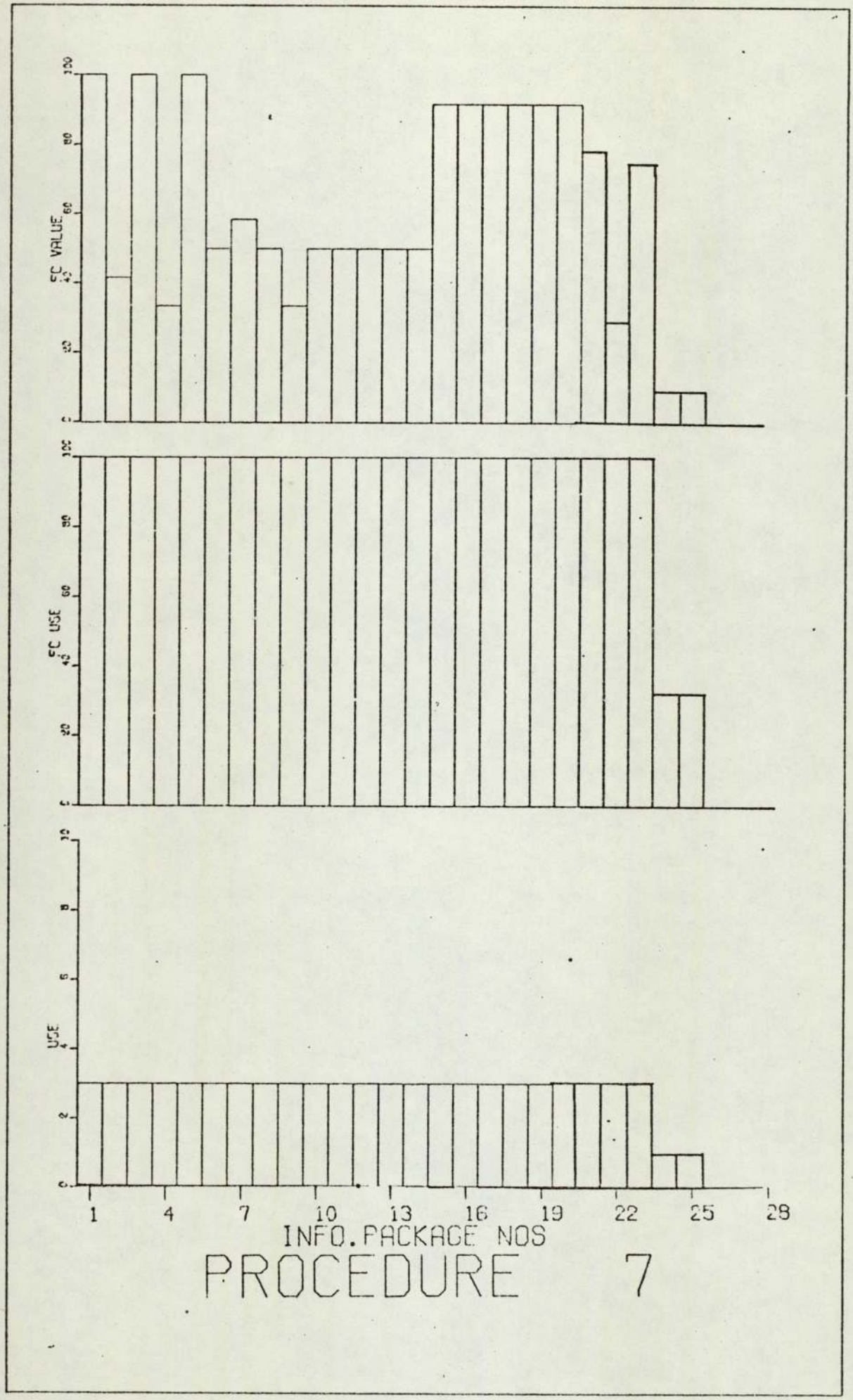

FIGURE 40

INFORMATION PACKAGES USED IN PROCEDURE 7

The analysis by information package, Figure 40, shows that 93% of the information packages were used in procedure 7. The average percentage value for the preliminaries section was 67%, although information packages 1, 3 and 5, Project Details, Form of Contract and Financial Details scored a percentage value of 100%. The preliminaries section was 46%, the measured work section 76%, and the prime cost and provisional sums section 8%.

7.8 Procedure 8 - Production Procurement Nominated Sub-Contractors and Suppliers

Only two tasks made direct reference to the bill of quantities in this procedure, making a possible 54 uses of information packages.

The actual use and value of the information used is shown in Figure 41.

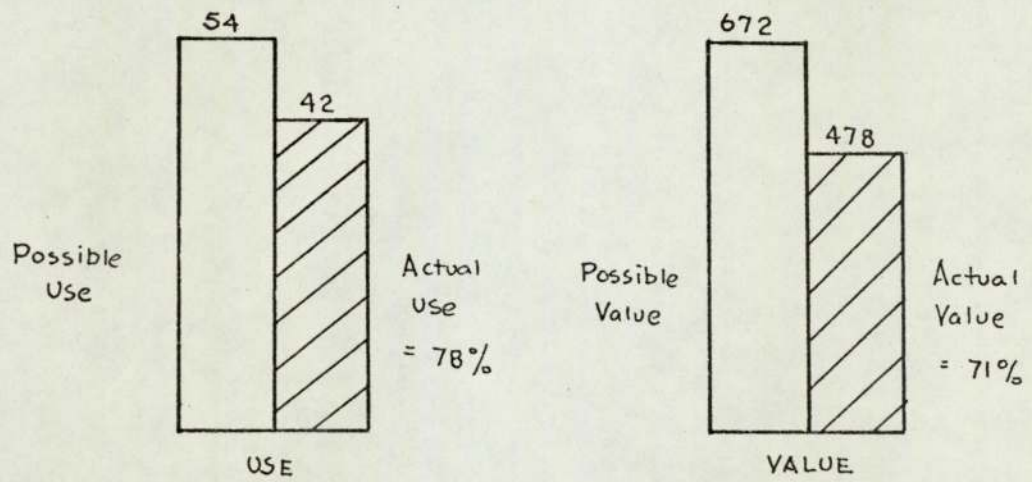

FIGURE 41

ACTUAL USE AND VALUE FOR PROCEDURE 8

The factors of sufficiency and accuracy contribute to the value of 478 in the approximate ratio of 48% sufficiency and 52% accuracy. The percentage use, and the percentage value of the information used in each task are shown in Figure 42.

Task	Percentage Use	Percentage Value
1	78%	68%
2	78%	74%

FIGURE 42

PERCENTAGE OF ACTUAL USE AND VALUE

FOR TASKS IN PROCEDURE 8

In the three procedures concerned with buying labour and material, namely Procedure 6 Procurement Materials, Procedure 7 Procurement Domestic Sub-Contractors, and Procedure 8 Procurement Nominated Sub-Contractors and Suppliers, it is significant that in every task other than task 1 of procedure 6, the percentage value of information is lower than the percentage use, indicating a certain unsuitability in the structure of the information for buying.

The analysis by information package, Figure 43 (Page 81), shows that 78% of the information packages were used in procedure 8.

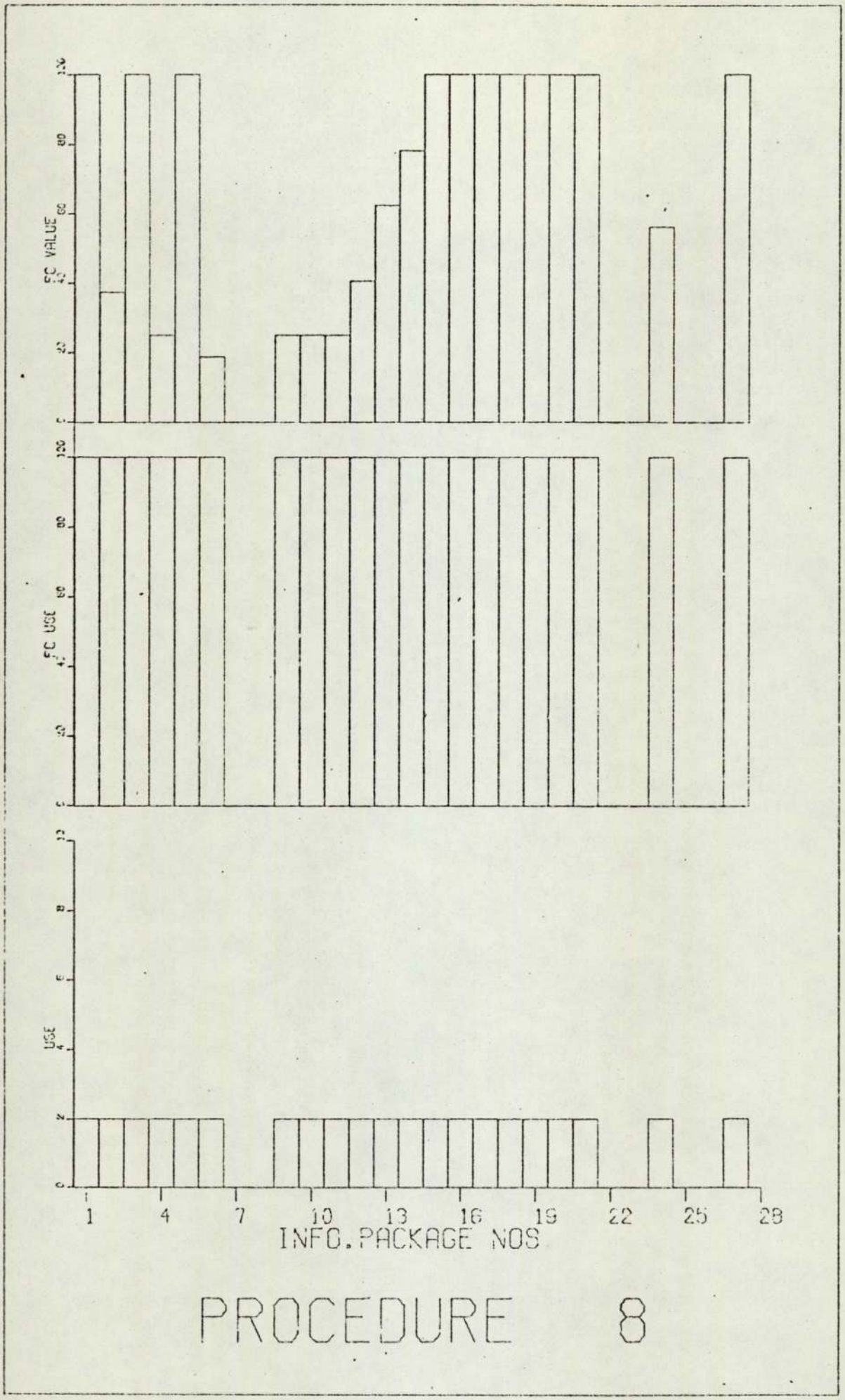

FIGURE 43

INFORMATION PACKAGES USED IN PROCEDURE 8

The average percentage value for the preliminaries section was 64%, for the preambles section 29%, for the measured work section 93%, and for the prime cost and provisional sum section 78%.

7.9 Procedure 9 - Production Progressing Off-Site Manufacture and Delivery

Only one task in procedure made direct use of the bill of quantities. The actual use and value of the information used by this task are shown in Figure 44.

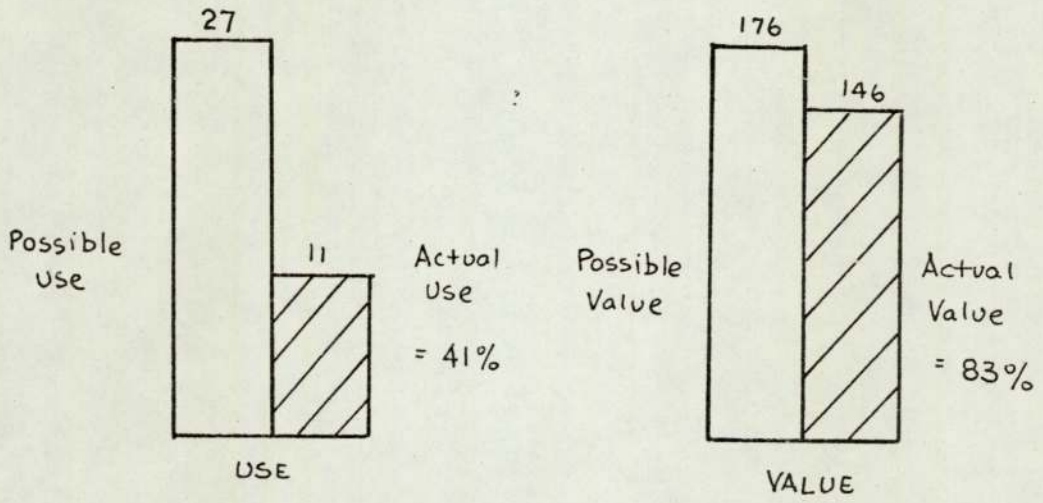

FIGURE 44

ACTUAL USE AND VALUE FOR PROCEDURE 9

The factors of sufficiency and accuracy each contribute to the value of 146 in the approximate ratio of 47% sufficiency and 53% accuracy. Although only 41% of the information was used, the percentage value rating of 83% indicates the high value

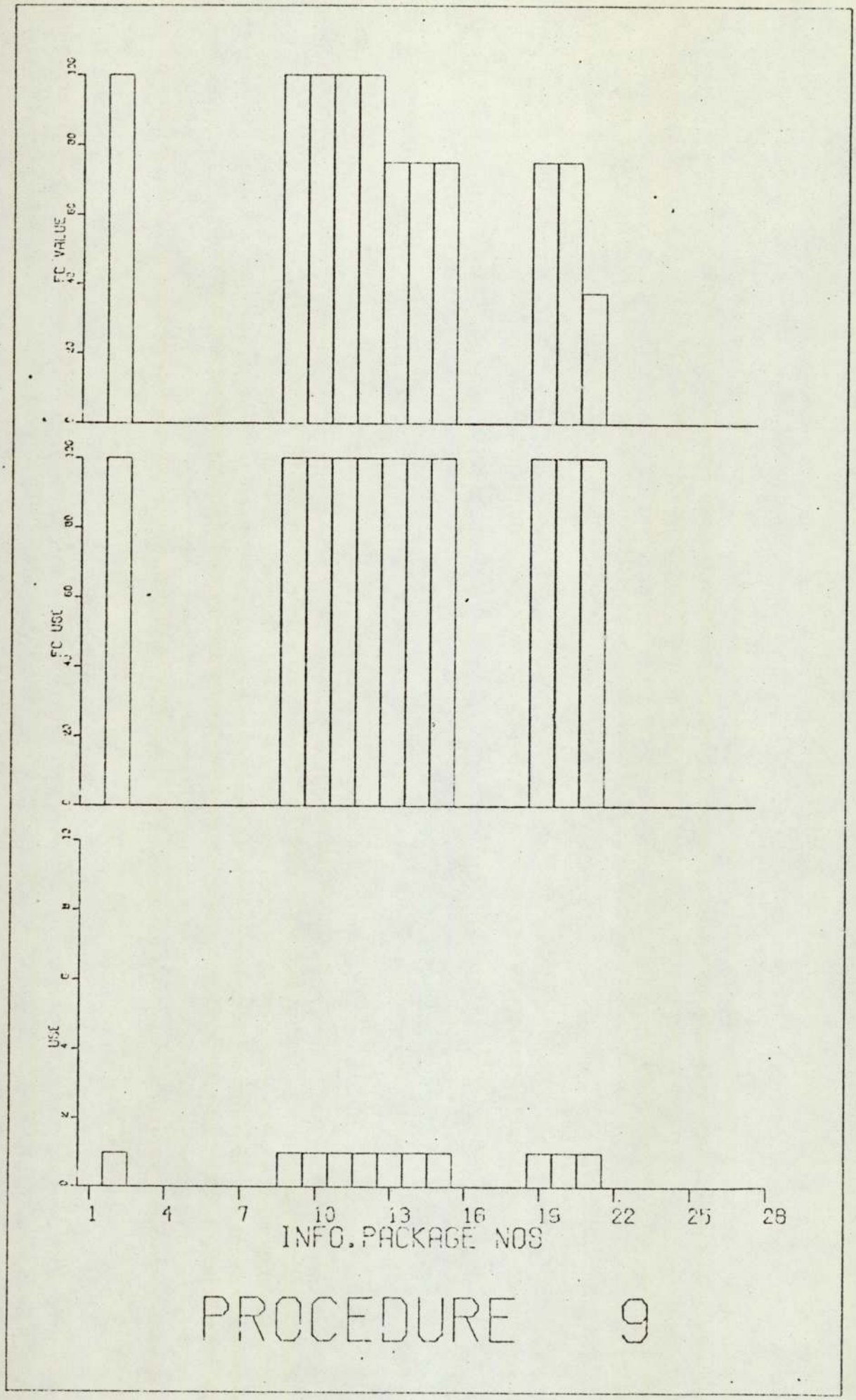

FIGURE 45

INFORMATION PACKAGES USED IN PROCEDURE 9

placed upon it.

Analysis by information package in Figure 45, shows that only one package, Site and Location, was used from the preliminaries section, and scored a percentage value rating of 100%. The whole of the information contained in the preambles section was used and again a percentage value rating of 100% was achieved. Six information packages from the measured work section were used, their average percentage value was 69%.

7.10 Procedure 10 - Production Progressing On-Site Manufacture

As in procedure 9, only one task made direct reference to the bill of quantities. The actual use and value of the information used are shown in Figure 46.

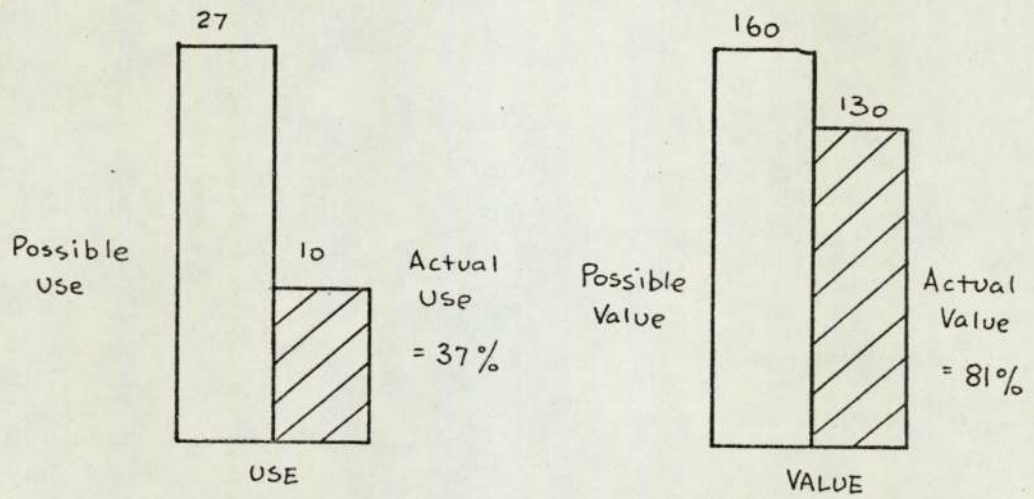

FIGURE 46

ACTUAL USE AND VALUE FOR PROCEDURE 10

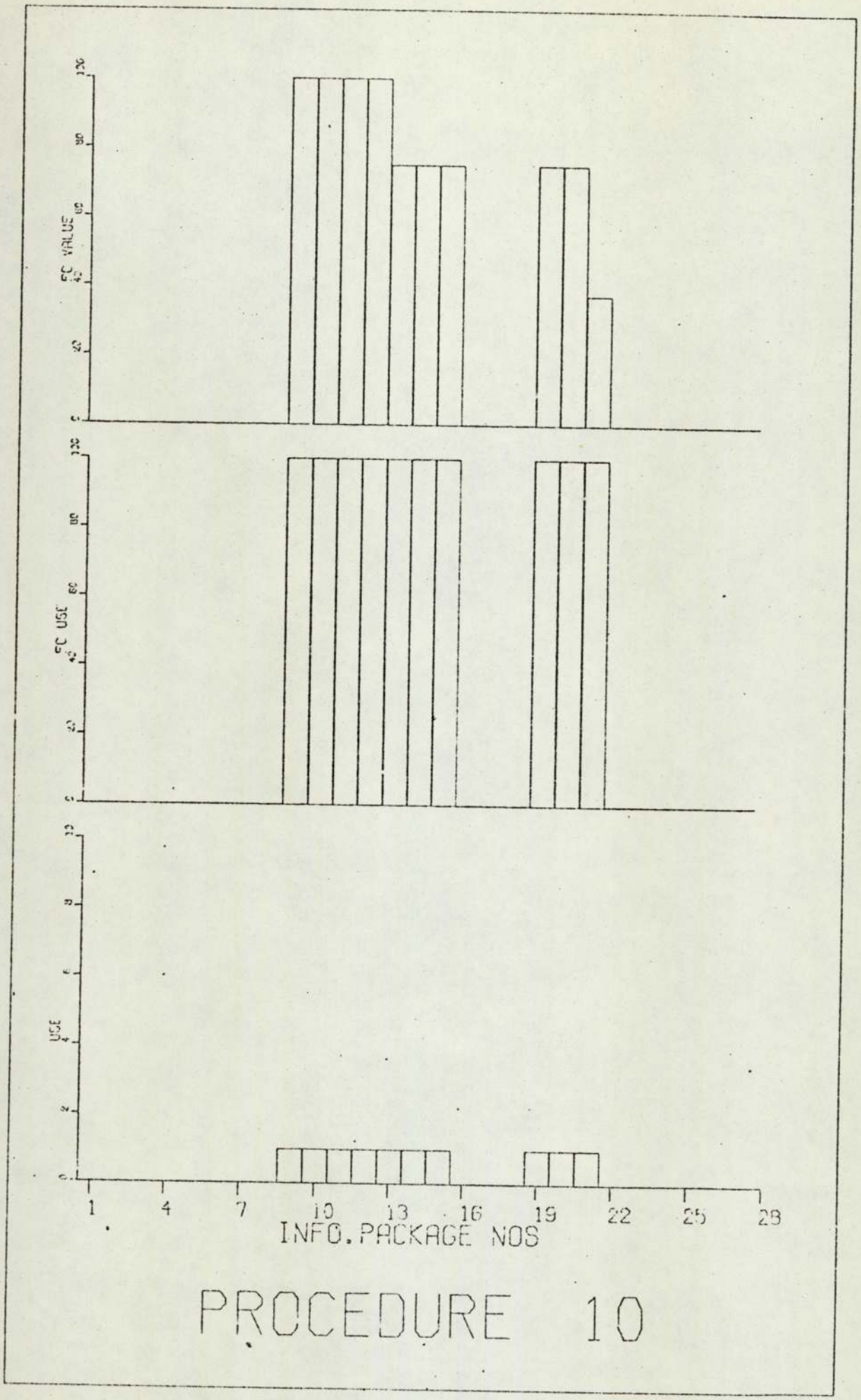

FIGURE 47

INFORMATION PACKAGES USED IN PROCEDURE 10

The two factors of sufficiency and accuracy contribute to the value of 130 in the approximate ratio of 47% sufficiency and 53% accuracy.

Analysis by information package in Figure 47, shows, with the exception of information package 2, the information used for Off-Site Manufacture and Delivery to be identical to that used for On-Site Manufacture. Also the percentage values are identical in the two procedures.

7.11 Procedure 11 - Production Progressing On-Site Distribution

Only one task in the procedure of On-Site Distribution made specific reference to the bill of quantities. The use and value of this information are shown in Figure 48.

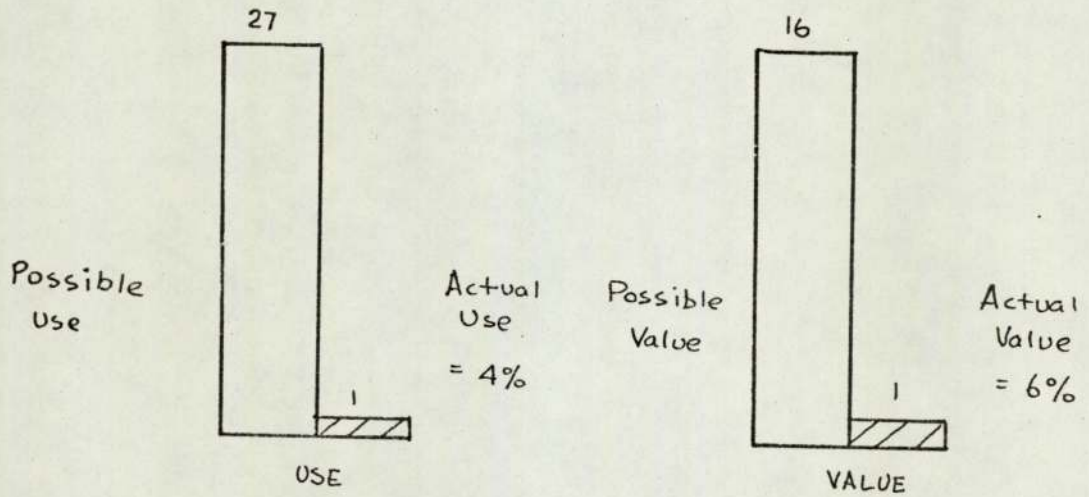

FIGURE 48

ACTUAL USE AND VALUE FOR PROCEDURE 11

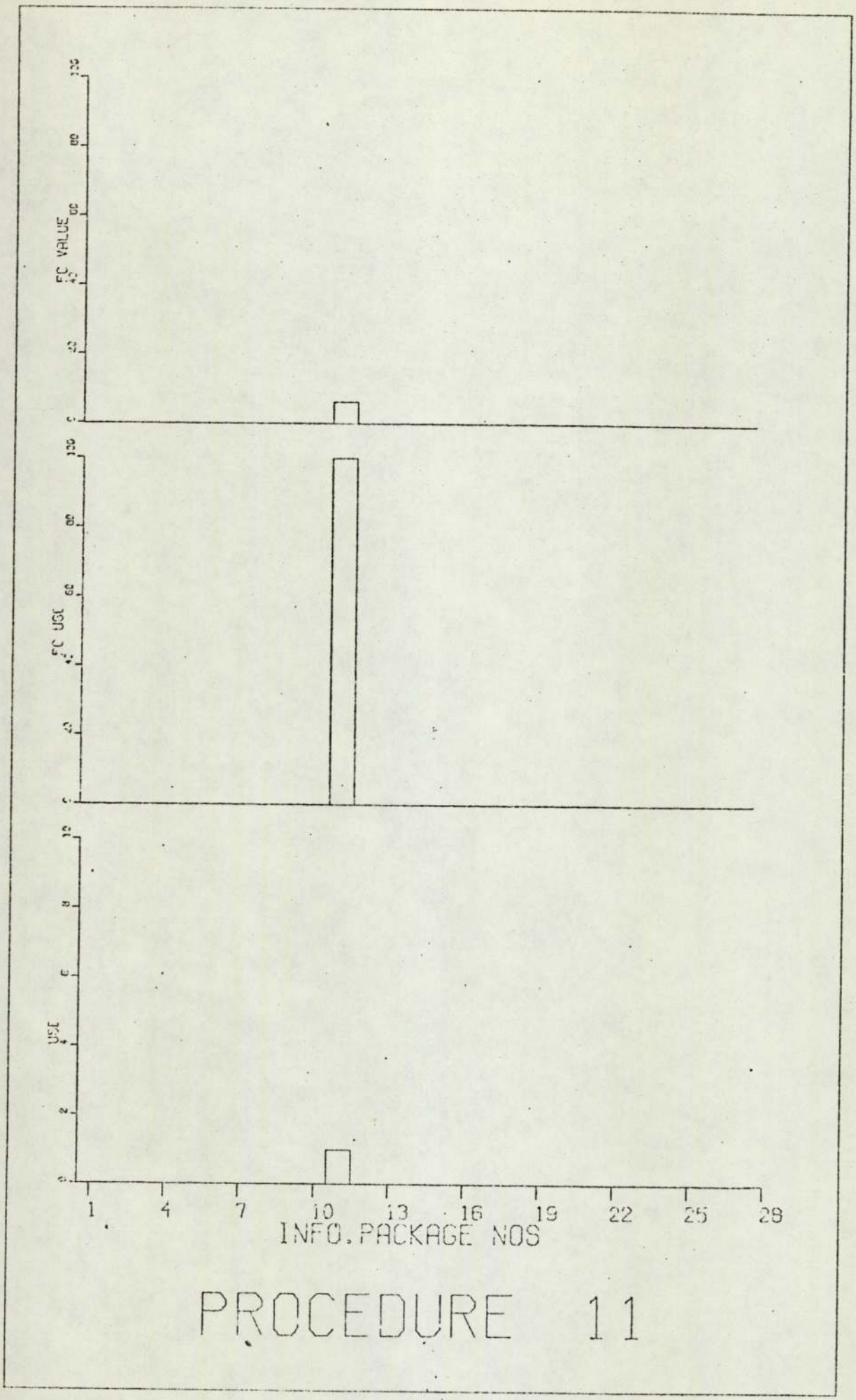

FIGURE 49

INFORMATION PACKAGES USED IN PROCEDURE 11

The factors of sufficiency and accuracy contribute in the ratio of 50% sufficiency and 50% accuracy.

Figure 49 shows the analysis by information package. Since the contractor consciously identified an isolated use of information having such a low value, two points may reasonably be deduced, firstly, the contractor recognised a need for locational information, and secondly, present bills of quantities do not structure this information in a manner best suited to the contractor's need.

7.12 Procedure 12 - Production Controlling Quality

Only one task in this procedure made direct reference to the bill of quantities. The use and value of the information used in this task are shown in Figure 50.

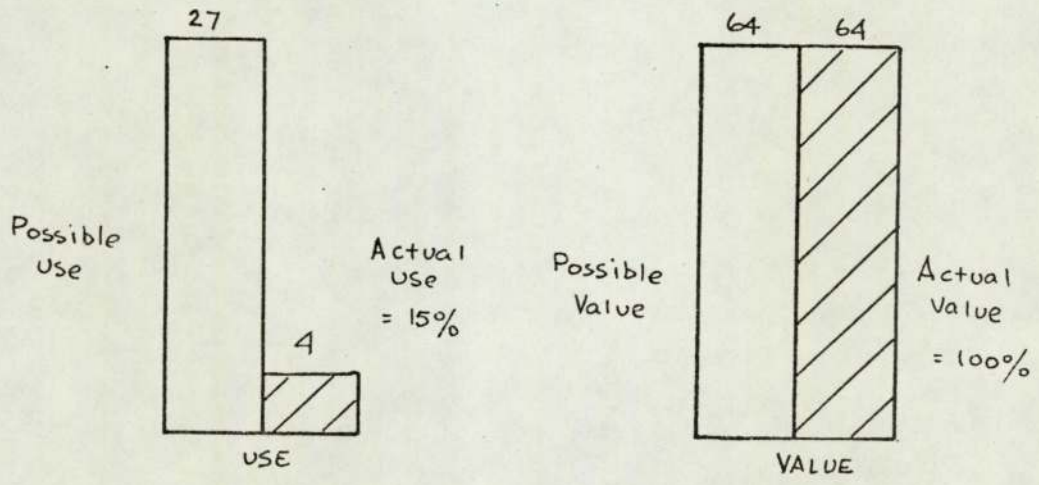

FIGURE 50

ACTUAL USE AND VALUE FOR PROCEDURE 12

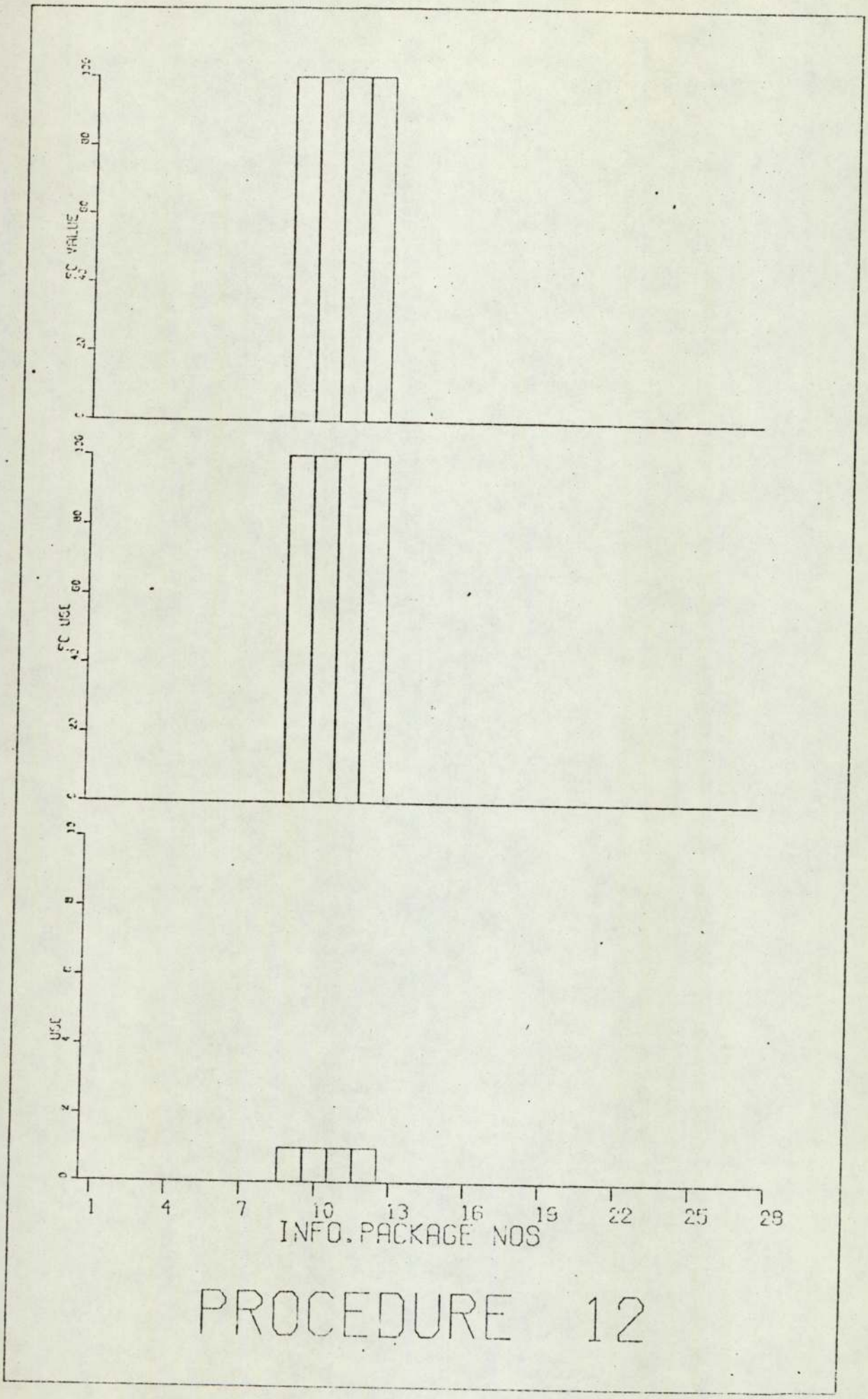

FIGURE 51

INFORMATION PACKAGES USED IN PROCEDURE 12

Clearly since the value is 100% the factors of sufficiency and accuracy contribute equally. This is only the second occasion identified in the research where the information used by a task has been rated with a 100% score.

Analysis by information package, Figure 51, shows that only the four information packages contained in the preamble section of the bill of quantities was used.

7.13 Procedure 13 - Production Payment to Main Contractor

Ten tasks were identified in this procedure making possible 270 uses of information. The actual use and value of the information used are shown in Figure 52.

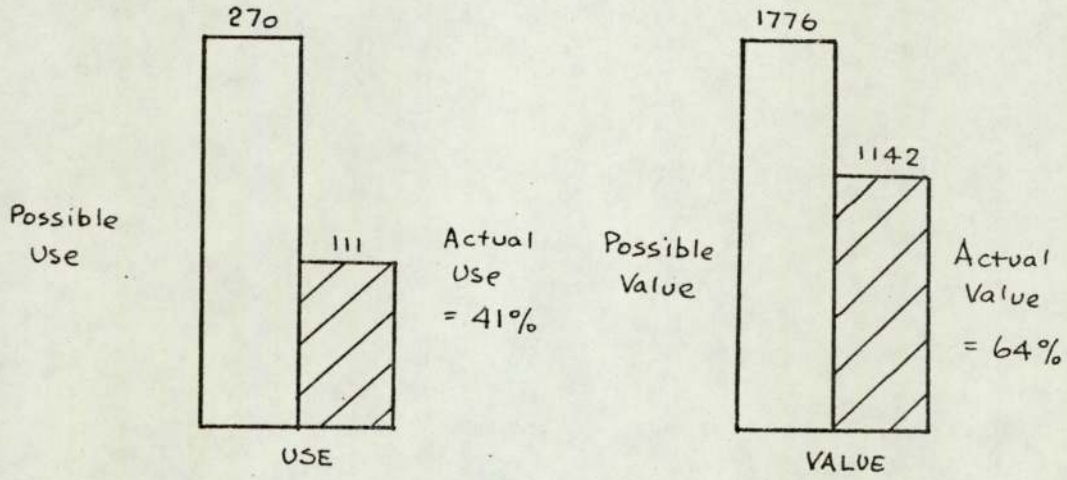

FIGURE 52

ACTUAL USE AND VALUE FOR PROCEDURE 13

The two factors of sufficiency and accuracy contribute to the value of 1,142 in the approximate ratio of 49% sufficiency and 51% accuracy.

The percentage use, and the percentage value of the information used in each task are shown in Figure 53.

Task	Percentage Use	Percentage Value
1	11%	83%
2	22%	84%
3	19%	73%
4	63%	85%
5	59%	68%
6	37%	44%
7	19%	95%
8	59%	80%
9	30%	83%
10	93%	25%

FIGURE 53

PERCENTAGE OF ACTUAL USE AND VALUE

FOR TASKS IN PROCEDURE 13

The percentage of information used in each task varies considerably, but no relationship exists between the percentage of information used and value. Task 10 has the highest percentage use but the lowest percentage value, conversely task 7 has one of the lowest percentage uses but the highest percentage

value. Since the bill of quantities is the major financial control document in the building industry, it may at first be thought that a low percentage use in this procedure would automatically result in a high value rating, and therefore the higher values would be found with the lower uses, and the lower values with the higher uses, however, this is not the case, task 4 has the second highest use and also the second highest percentage value.

Analysis by information package, Figure 54 (Page 93), shows that the whole of the information contained in the bill of quantities was used in this procedure.

The average percentage use for the preliminaries section was 50%, for the preamble section 38%, for the measured work section 37%, and the prime cost and provisional sum section 35%. The average percentage value for the preliminaries section was 61%, for the preamble section 65%, for the measured work section 67%, and the prime cost and provisional sum section 35%.

There were four information packages in the preliminaries section with a percentage value over 70%, Project Details, Form of Contract, Financial Details, and Facilities and Services. One information package, Material Specification, exceeded this percentage in the preamble section, and five information packages, Locational Details, Quantity Units, Unit Rates, Rate Extensions, and Extension Totals, in the measured work section.

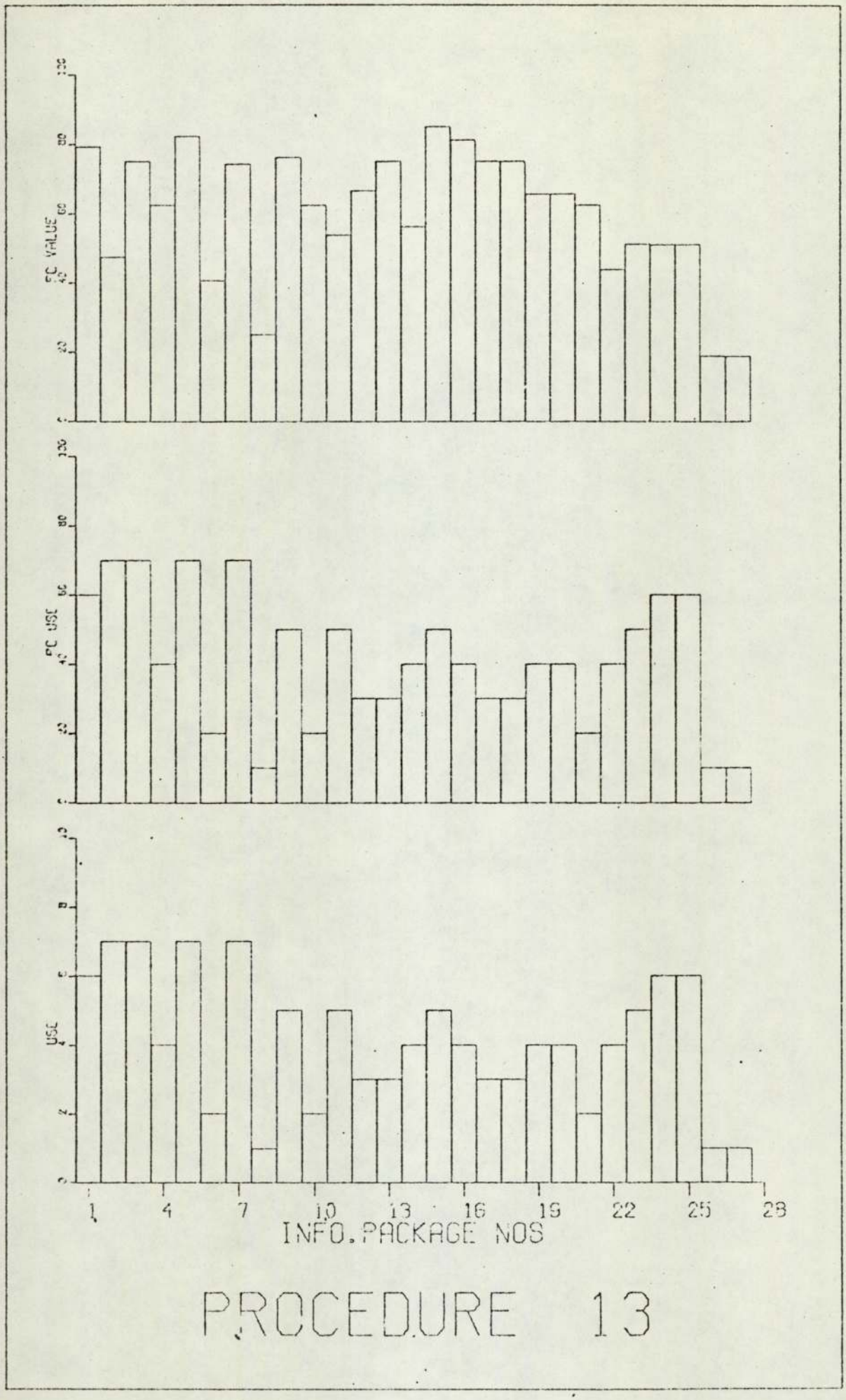

FIGURE 54

INFORMATION PACKAGES USED IN PROCEDURE 13

Surprisingly the information package with the highest percentage value in this procedure was not the Unit Rates, but the Quantity Units. The Quantity Units was also the most used information package in the measured work section.

A sharp contrast exists between the prime cost items and the provisional sum items. The percentage value for the prime cost items was 51% compared with only 19% for provisional sum items, while the percentage use of prime cost items was 60% compared with 10% for provisional sum items.

7.14 Procedure 14 - Production Payment by Main Contractor

Five tasks were identified in this procedure making possible 135 uses of information. The actual use and value of the information used are shown in Figure 55.

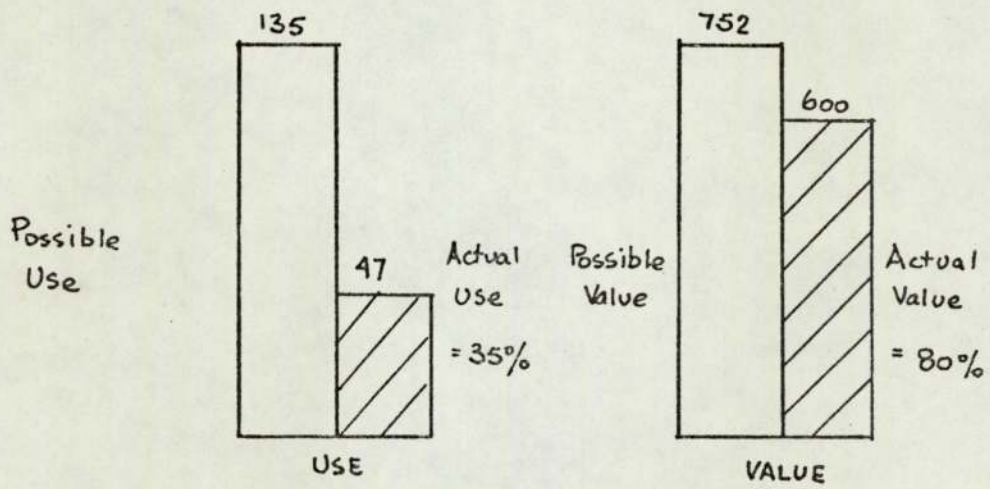

FIGURE 55

ACTUAL USE AND VALUE FOR PROCEDURE 14

The two factors of sufficiency and accuracy contribute to the value of 600 in the approximate ratio of 48% sufficiency and 52% accuracy.

The percentage use, and the percentage value of the information used in the five tasks are shown in Figure 56.

Task	Percentage Use	Percentage Value
1	22%	75%
2	41%	89%
3	63%	77%
4	22%	75%
5	26%	80%

FIGURE 56

PERCENTAGE OF ACTUAL USE AND VALUE

FOR TASKS IN PROCEDURE 14

Although the actual percentage of information used in this procedure is less than that used in Procedure 13 - Production Payment to Main Contractor, the percentage value of the information used is 16% higher. Clearly the contractor will leave those suppliers and sub-contractors to whom payment is due, to question the information upon which their contract was formed, whereas he in turn will be expected to raise any doubts concerning the accuracy of information as a means of

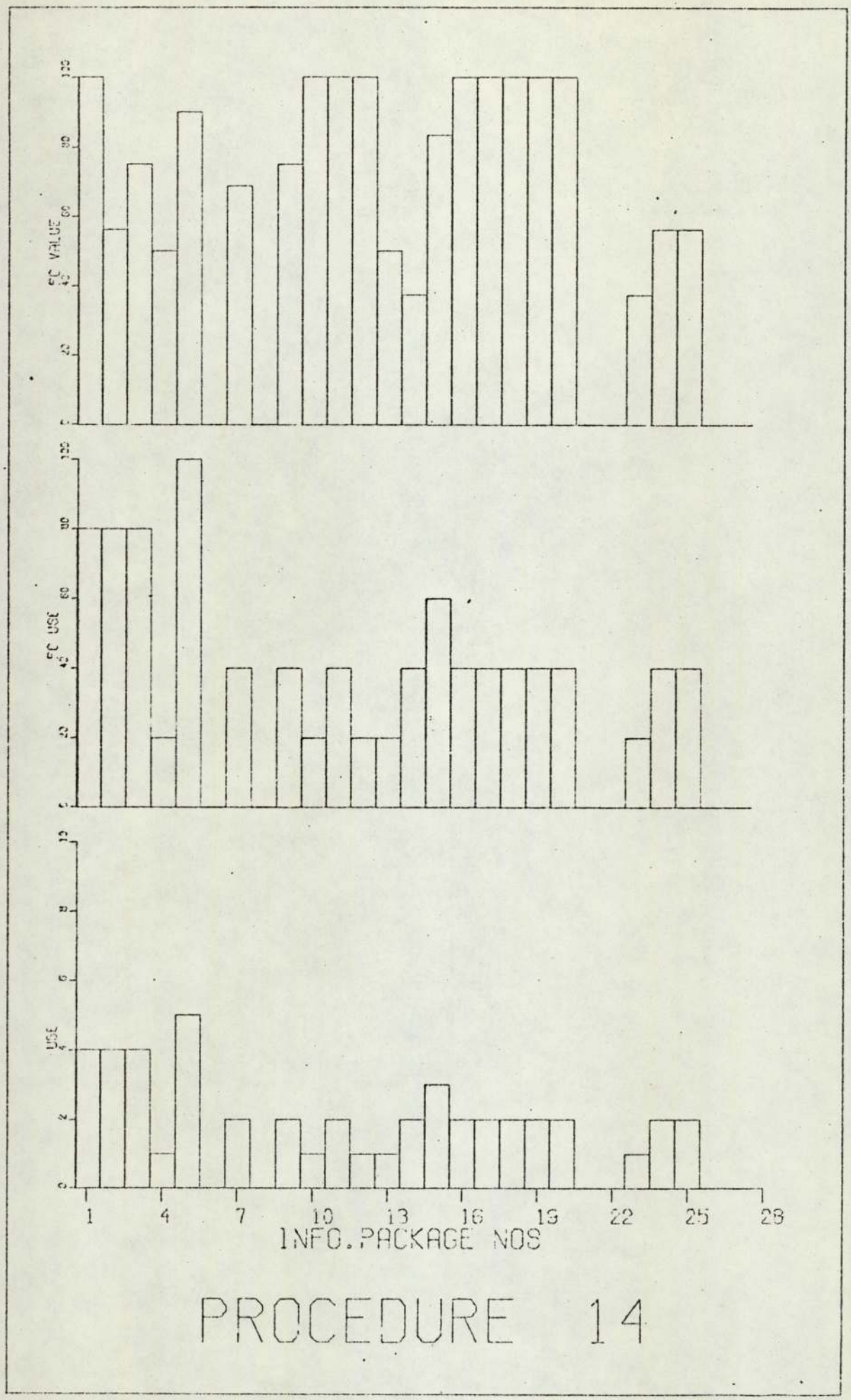

FIGURE 57

. INFORMATION PACKAGES USED IN PROCEDURE 14

expressing the monetary value of work for which he is contractually responsible.

The contractor will therefore place less value upon the bill of quantities when being paid, than he will when making payments.

Analysis by information package, Figure 57, shows that 78% of the information packages were used by the contractor in this procedure. Information package 5, Financial Details, was used 100%.

The average percentage value for the preliminaries section was 73%, for the preamble section 94%, for the measured work section 79%, and the prime cost and provisional sum section 56%.

Information packages 1, Project Details, 10, Workmanship, 11, Handling and Placing Materials, 12, Tests and Samples, 16, Unit Rates, 17, Rate Extension, 18, Extension Totals, 19, Work Description, and 20, Description Dimensions, all scored a percentage value of 100%.

7.15 Integrated Tasks in Time Order

As discussed in Chapter V, and shown in Figures 7 and 8, the tasks in the fourteen procedures were re-arranged into a time sequence. By adding vertically the individual task performances together, twenty-nine different totals were obtained, see Figure 58 (Page 98), which represents the changing

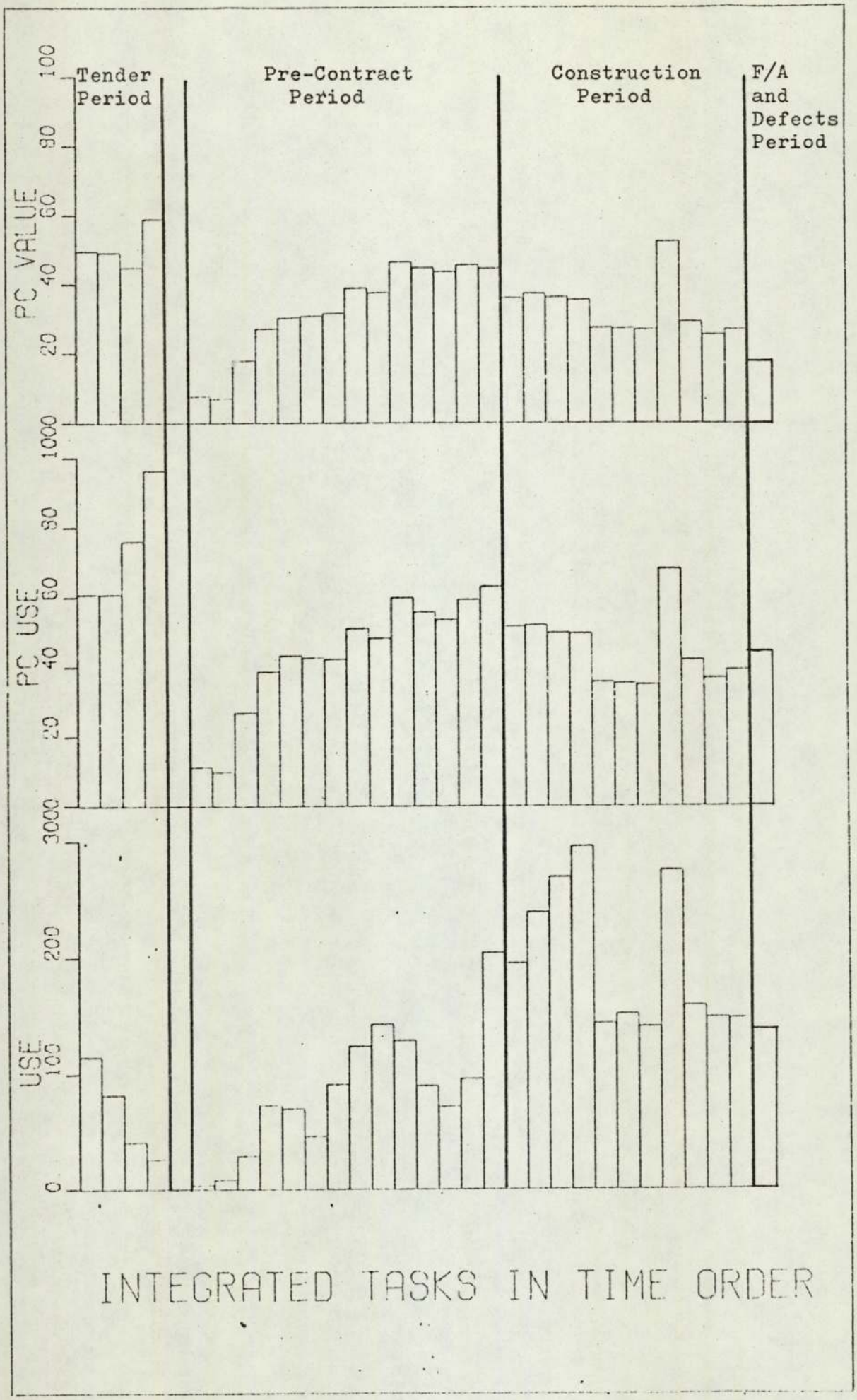

FIGURE 58

TOTAL INTEGRATED TASKS IN TIME ORDER

use of the bill of quantities throughout the tendering, pre-contract, construction, and the defects liability and final account periods.

Examination of Figure 58 shows that the use of information rose to a peak of 295 uses in the early stages of construction, compared with a maximum of 115 uses in the tendering period, an increase of over 250%. However, by an examination of the percentage use in Figure 58, it may be seen that the use of 295 is only 52% of possible use.

The differential between actual use and possible use of the bill of quantities for the integrated tasks in time order is diagramatically shown in Figure 59.

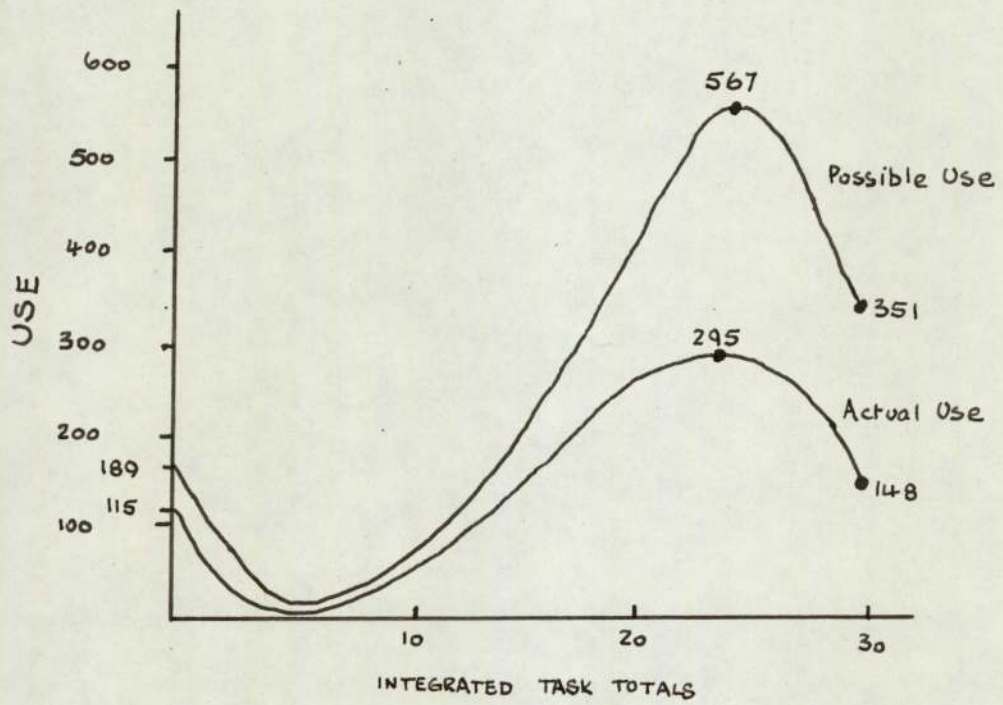

FIGURE 59

DIFFERENTIAL BETWEEN USE AND POSSIBLE USE OF THE BILL OF QUANTITIES

The individual contributions made by the preliminaries, preambles, measured work, and the prime cost and provisional sums sections of the bill of quantities to the totals of use and value are shown in Figures 60, 61, 62 and 63.

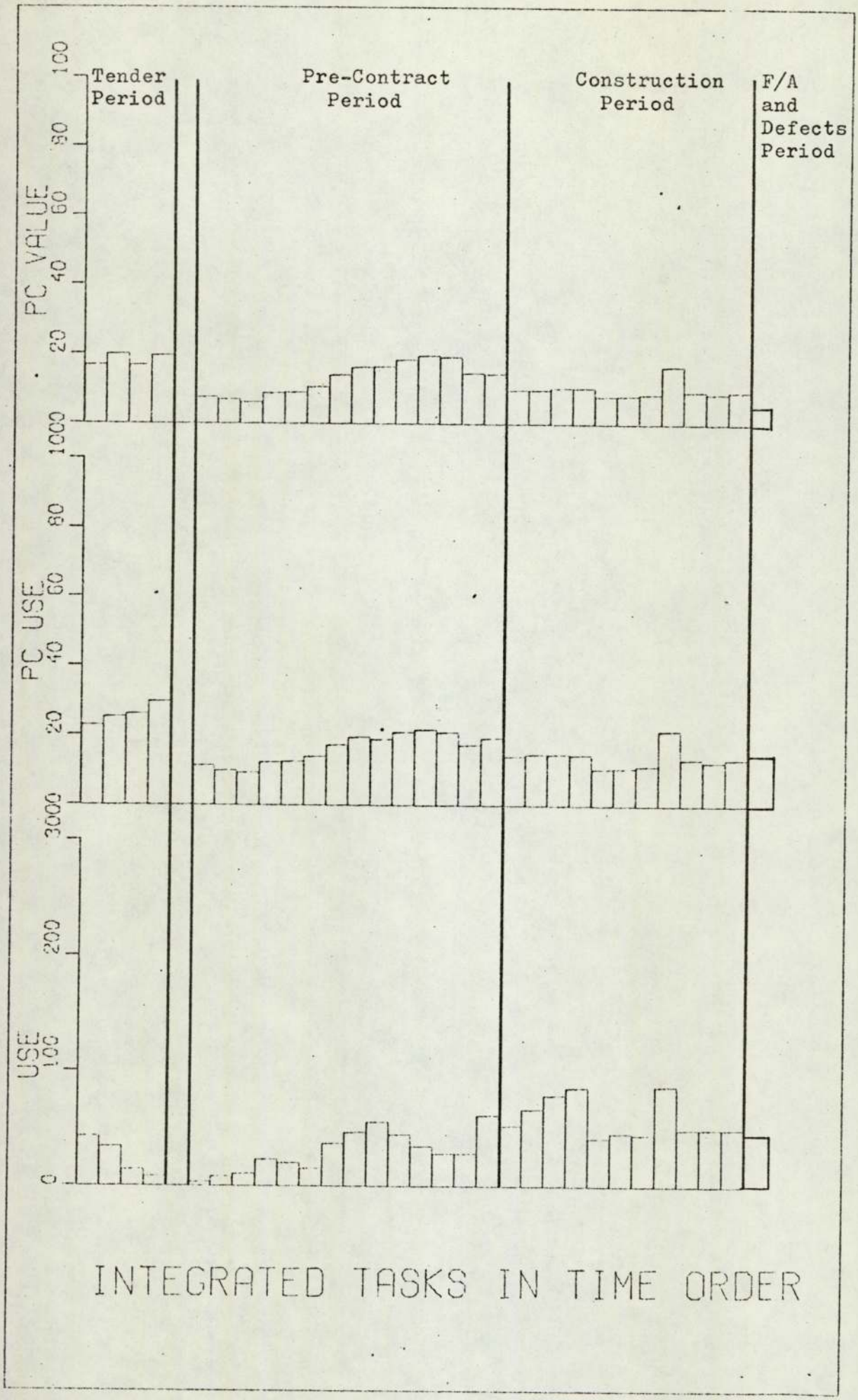

FIGURE 60

PRELIMINARIES CONTRIBUTION TO INTEGRATED TASKS IN TIME ORDER

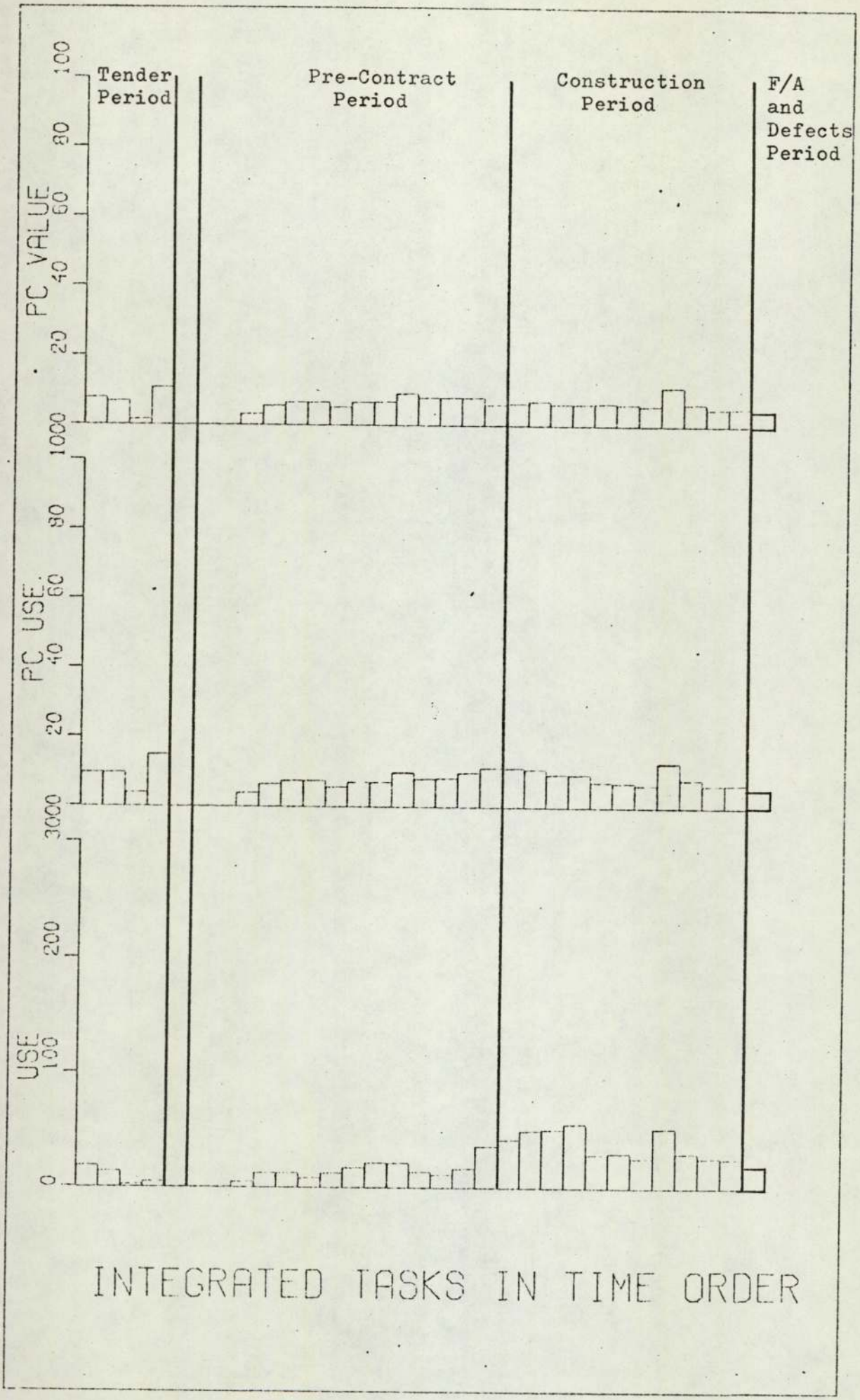

FIGURE 61

PREAMBLE CONTRIBUTION TO INTEGRATED TASKS IN TIME ORDER

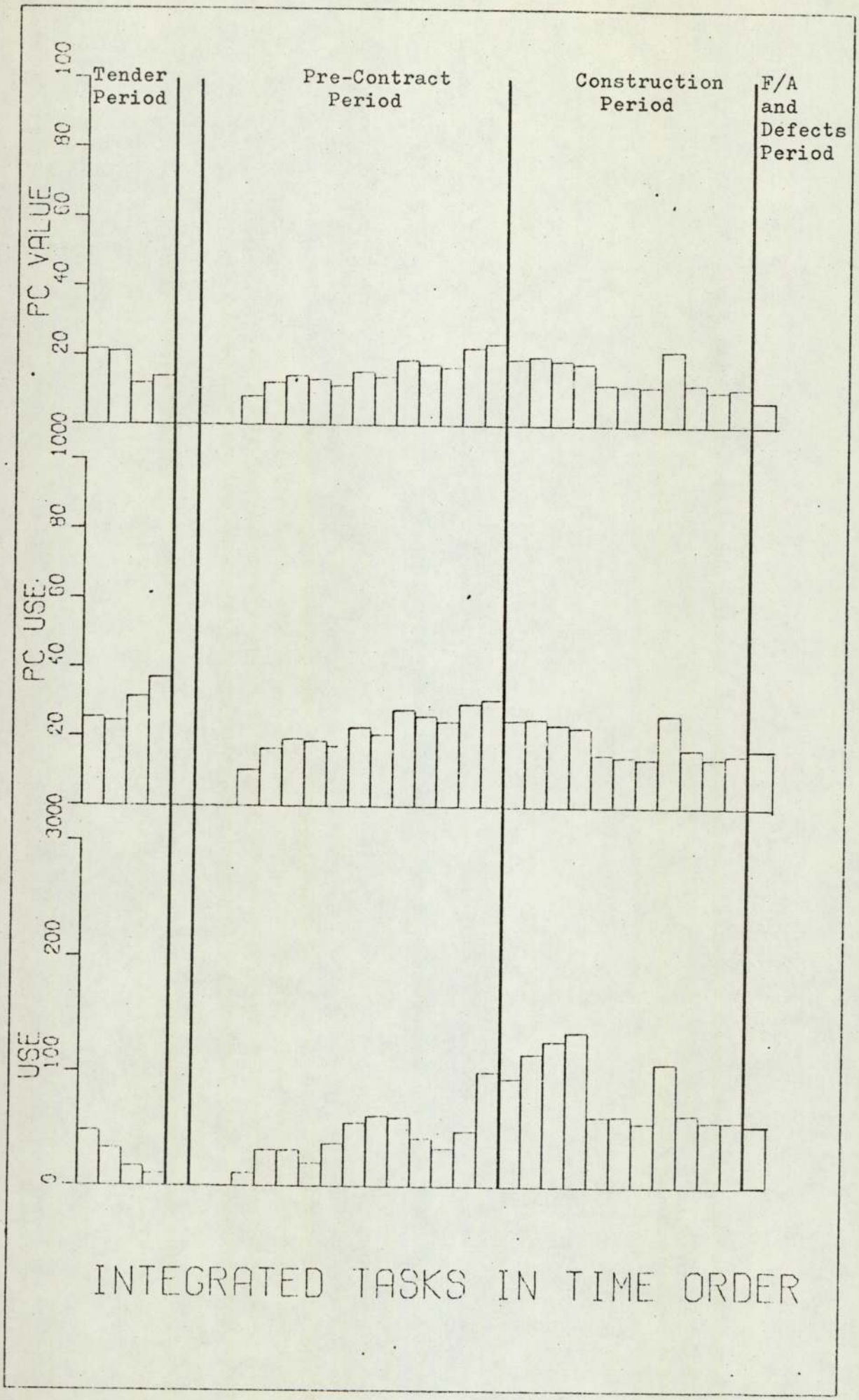

FIGURE 62

MEASURED WORK CONTRIBUTION TO INTEGRATED TASKS IN TIME ORDER

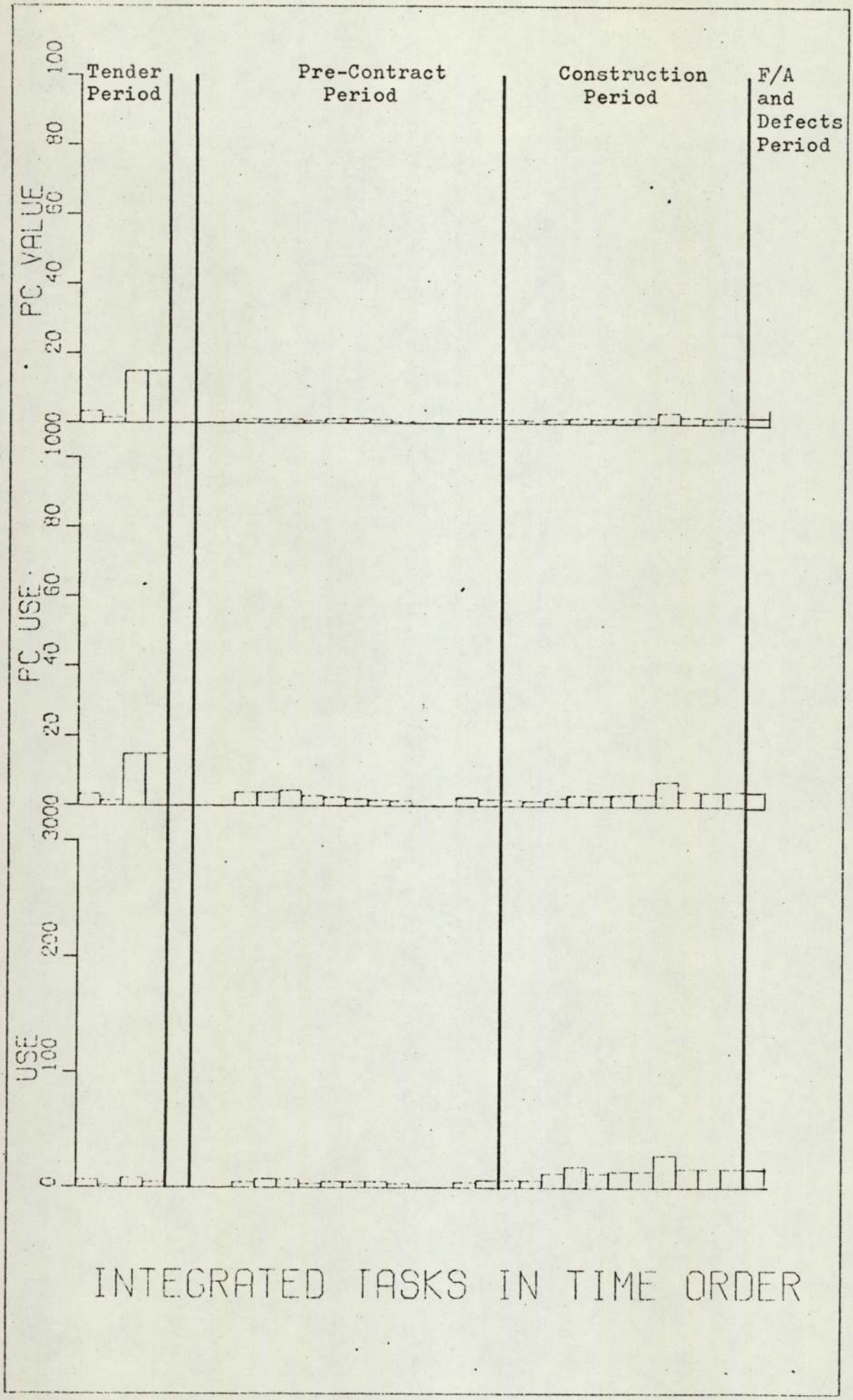

FIGURE 63

PRIME COSTS AND PROVISIONAL SUMS CONTRIBUTION TO INTEGRATED TASKS IN TIME ORDER

C H A P T E R V I I I

EVALUATION

8.1 Conclusions

The research clearly shows that bills of quantities are well used by the contractor in a wide variety of situations, and constitutes an important communication link between design and construction.

There has been a call for change, but it must be emphasised that any proposals should take account of the whole contribution which the bill makes to the contractor's work, for only then will current documentation be surpassed, and the industries' need satisfied.

Figure 64 (Page 106) clearly demonstrates that the bill is still used primarily for the area it was designed to serve, although its use has extended to other areas due largely to improved technology and new production methods.

Since the contractor consciously uses so little information in Production Progressing On-Site Distribution, one may conclude that a need exists for structured locational information which is not being satisfied at the present time. The point is emphasised in Figure 65 (Page 107), since only information package 11, Handling and Placing Materials, is used by every procedure.

Procedure	No. of Uses
Tender Estimating Pricing	131
Production Payment to Main Contractor ..	111
Tender Estimating Planning	98
Production Planning Strategic	84
Production Procurement Domestic Sub-Contractors	71
Production Planning Tactical	53
Production Procurement Materials	49
Production Payment by Main Contractor ..	47
Production Procurement Nominated Sub-Contractors and Suppliers	42
Production Procurement Plant	25
Production Progressing Off-Site Manufacture and Delivery	11
Production Progressing On-Site Manufacture	10
Production Controlling Quality	4
Production Progressing On-Site Distribution	1

FIGURE 64

PROCEDURES IN ORDER OF USE

Figure 65 (Page 107) shows that the information used most falls into three main areas, firstly, Site and Location, and Times and Phasing, secondly, Work Quantities and Quantity Units, and thirdly, Work Descriptions and Description Dimensions, which emphasises the need that exists for measured

Information Package	Procedures														Total Use
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	4	5	6	2	1	2	3	2	0	0	0	0	6	4	35
2	5	6	7	3	2	2	3	2	1	0	0	0	7	4	42
3	2	4	3	3	1	2	3	2	0	0	0	0	7	4	31
4	6	7	8	3	1	3	3	2	0	0	0	0	4	1	38
5	0	7	2	2	1	2	3	2	0	0	0	0	7	5	31
6	6	7	2	3	2	2	3	2	0	0	0	0	2	0	29
7	6	7	4	0	1	0	3	0	0	0	0	0	7	2	30
8	6	7	2	3	1	0	3	0	0	0	0	0	1	0	23
9	4	5	3	2	0	3	3	2	1	1	0	1	5	2	32
10	3	4	3	2	1	2	3	2	1	1	0	1	2	1	26
11	4	5	3	2	1	2	3	2	1	1	1	1	5	2	33
12	2	4	3	1	0	2	3	2	1	1	0	1	3	1	24
13	4	3	3	3	1	3	3	2	1	1	0	0	3	1	28
14	5	6	4	3	2	3	3	2	1	1	0	0	4	2	36
15	5	6	4	3	2	3	3	2	1	1	0	0	5	3	38
16	0	2	3	2	1	2	3	2	0	0	0	0	4	2	21
17	0	2	2	1	0	2	3	2	0	0	0	0	3	2	17
18	0	2	2	1	0	2	3	2	0	0	0	0	3	2	17
19	6	7	3	3	2	3	3	2	1	1	0	0	4	2	37
20	6	7	3	3	2	3	3	2	1	1	0	0	4	2	37
21	5	6	3	2	1	2	3	2	1	1	0	0	2	0	28
22	5	6	2	3	1	3	3	0	0	0	0	0	4	0	27
23	5	6	2	3	1	1	3	0	0	0	0	0	5	1	27
24	2	3	2	0	0	0	1	2	0	0	0	0	6	2	18
25	5	3	2	0	0	0	1	0	0	0	0	0	6	2	19
26	1	2	2	0	0	0	0	0	0	0	0	0	1	0	6
27	1	2	1	0	0	0	0	2	0	0	0	0	1	0	7

FIGURE 65

SUMMARY OF INFORMATION PACKAGES USED WITHIN PROCEDURES

information. This conclusion is endorsed by the fact that information package 15, Quantity Units, has a higher value, see Figure 66 (Page 109), than any other information package.

The poor use of the information packages relating to money, namely Unit Rates, Rate Extensions, and Extension Totals, indicate that the structure of existing bills of quantities do not allow for the identification of the most pertinent costs incurred in building.

Figures 65 and 66 together show that the value of information is not directly proportional to its use. The consideration of two examples demonstrate this, firstly, information package 4 is used seven times, or 23%, more than information package 3, yet the value of information package 3 is 13% greater. Again, information package 15 is used only twice, or 6%, more than information package 14, yet the value of information package 15 is 41% greater than that of information package 14.

The disparity which exists between the values of individual information packages used at different times and for different purposes, confirms that bills of quantities are not ideally structured to satisfy the enormous demands made upon them.

By arranging the tasks in time sequence it was discovered, contrary to all expectations, that the biggest use of the bill of quantities occurs early in the construction

Information Package	Procedures														Total Value
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	48	60	76	32	16	32	48	32	0	0	0	0	76	64	484
2	54	76	80	32	24	32	20	12	16	0	0	0	53	36	435
3	24	44	48	48	16	32	48	32	0	0	0	0	84	48	424
4	66	92	72	32	8	32	16	8	0	0	0	0	40	8	374
5	0	112	32	32	16	32	48	32	0	0	0	0	92	72	468
6	48	44	32	41	17	8	24	6	0	0	0	0	13	0	233
7	72	84	46	0	1	0	28	0	0	0	0	0	83	22	336
8	72	84	32	48	16	0	24	0	0	0	0	0	4	0	280
9	48	60	32	24	0	24	16	8	16	16	0	16	61	24	345
10	36	32	48	32	16	8	24	8	16	16	0	16	20	16	288
11	42	40	36	32	16	8	24	8	16	16	1	16	43	32	330
12	32	64	48	16	0	20	24	13	16	16	0	16	32	16	313
13	48	36	27	40	12	44	24	20	12	12	0	0	36	8	319
14	54	60	56	36	18	21	24	25	12	12	0	0	36	12	366
15	70	76	56	40	18	48	44	32	12	12	0	0	68	40	516
16	0	12	40	24	12	20	44	32	0	0	0	0	52	32	268
17	0	12	28	12	0	20	44	32	0	0	0	0	36	32	216
18	0	12	28	12	0	20	44	32	0	0	0	0	36	32	216
19	86	92	40	36	28	40	44	32	12	12	0	0	42	32	496
20	86	92	40	36	28	40	44	32	12	12	0	0	42	32	496
21	70	76	18	12	6	14	38	32	6	6	0	0	20	0	298
22	38	44	4	13	2	36	14	0	0	0	0	0	28	0	179
23	54	60	28	33	12	9	36	0	0	0	0	0	41	6	279
24	32	48	8	0	0	0	4	18	0	0	0	0	49	18	177
25	80	48	8	0	0	0	4	0	0	0	0	0	49	18	207
26	16	32	8	0	0	0	0	0	0	0	0	0	3	0	59
27	16	32	4	0	0	0	0	32	0	0	0	0	3	0	87

FIGURE 66

SUMMARY OF INFORMATION PACKAGE VALUES

WITHIN PROCEDURES

period, also this use was more than two and a half times the largest use identified in the tendering period. These facts are not readily appreciated since so many tasks contribute to the total. However, it clearly demonstrates that the current use of the bill of quantities far exceeds anything which could have been anticipated in the production of a tender document.

8.2 Recommendations

The research should be repeated with a larger number of contractors.

A similar study should be undertaken to ascertain the design team's use of the bill of quantities.

A detailed examination of the factors affecting information value should be undertaken leading to a recommendation for a revised structure of bills of quantities.

A more comprehensive study of the contractor's use of the bill of quantities during the construction period be undertaken, using specific contracts and case studies.

An evaluation of the arrangement and presentation of existing bills of quantities be undertaken.

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APPENDIX A

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APPENDICES

APPENDIX A

THE PILOT STUDY

A.1 Company Trading

The company has extensive experience in building and civil engineering work and obtains the majority of its contracts in the traditional method of competitive tenders based on bills of quantities. The rate of successful tenders, omitting cover price bids, falls well within the success rate identified by Moyles[61] as 1 in 6 to 1 in 9.

The expansion of the company turnover from £35 million in 1968 to £52 million in 1972, an increase of 48.5%, is indicative of the growth and efficiency of the company. Not that turnover figures alone spell efficiency, but a sustained growth over a number of years, coupled with a successful competitive tendering pattern support the observation.

Although the company has no declared policy with respect to an upper or lower limit on contract values, observations indicate that contracts under £100,000 are the exception rather than the rule. The larger value contracts provide greater continuity of work for the company and regular employment for site staff, both of which are to be preferred in an industry where there is a great mobility of labour, and considerable variety in the geographical location of construction sites.

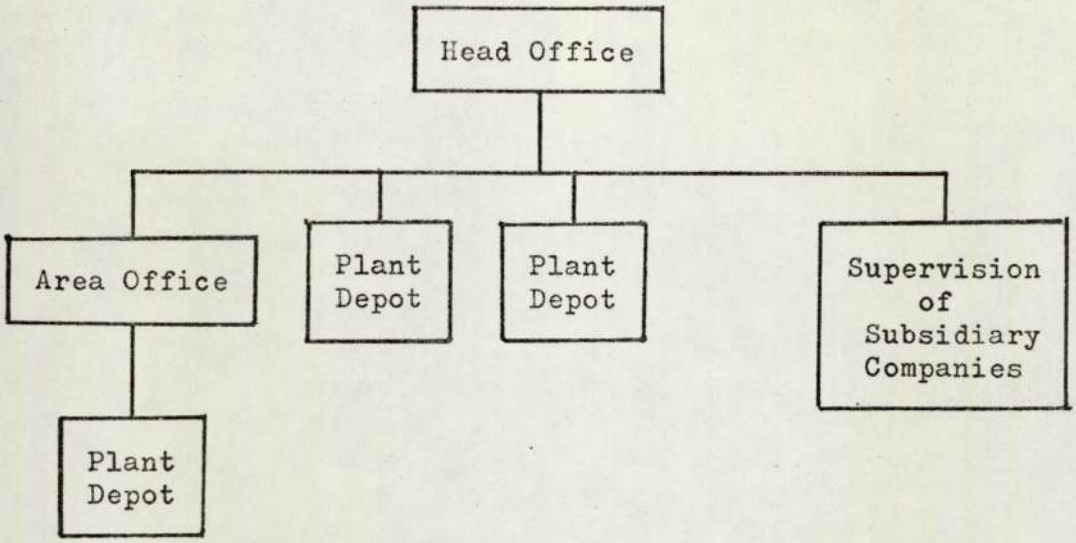

FIGURE 67

THE COMPANY STRUCTURE

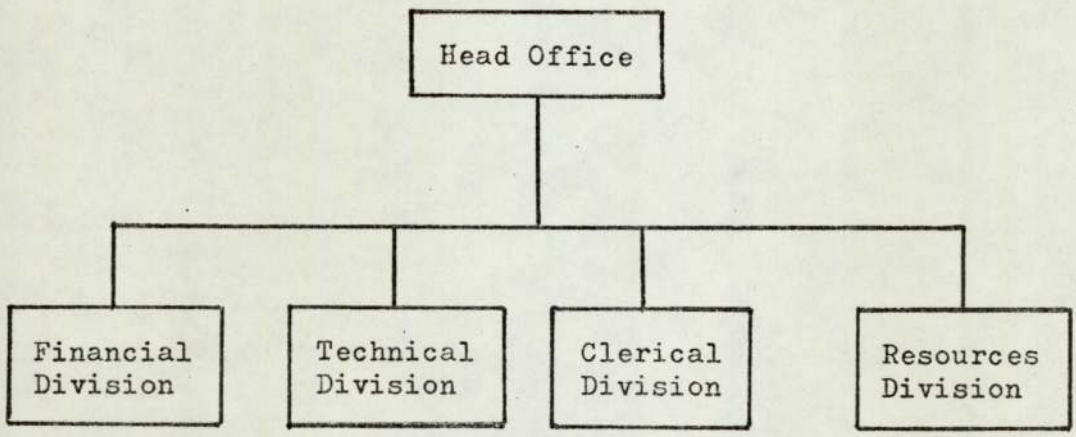

FIGURE 68

COMPANY DIVISIONS

The company is therefore able to maintain a substantial labour force of 2,500 office staff and 5,000 site operatives in its own employment, which is supplemented from time to time as required. Despite this considerable work force, the company still find it necessary to maintain a policy of employing sub-contractors. This, however, is not peculiar to this company, nor is it related to individual locations, but is a characteristic feature of the construction industry.

A.2 The Overall Structure.

The external structure of the company organisation is shown in Figure 67, and although the head office is ultimately responsible for the work of the area office and the profitability of deploying plant and equipment from plant depots, each of these subsidiary organisations is responsible for their own administration and productivity. A detailed investigation of the head office organisation was considered sufficient to cover both the head office and area office organisations since they are structured in a similar manner.

The basic divisions identified within the company were, Financial, Technical, Clerical and Resources as shown in Figure 68. These divisions are office divisions and do not include the Site Administration, which must be considered as a fifth and separate division.

It must be stressed that despite the necessity for the company to establish these divisions and formulate procedure

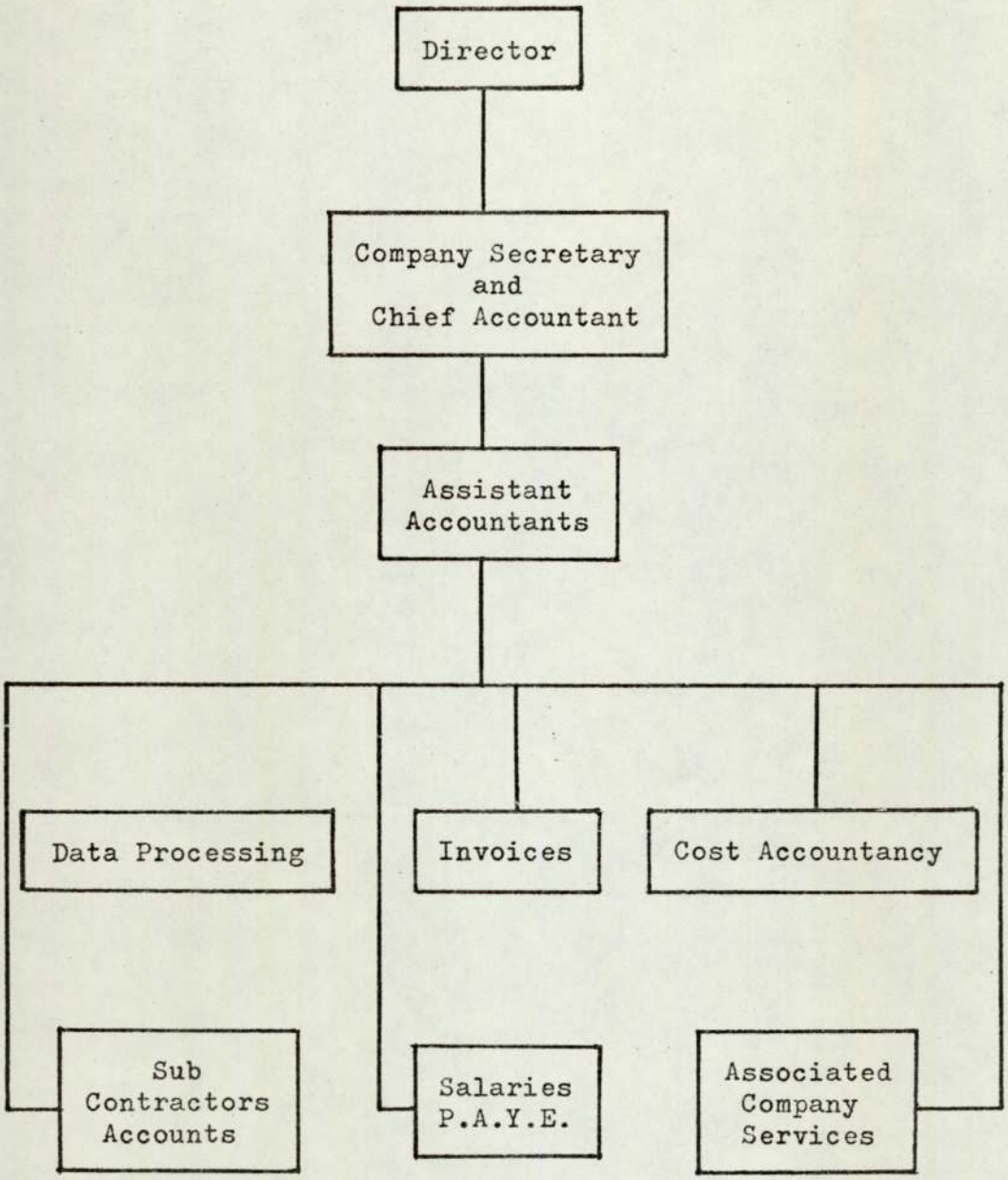

FIGURE 69

FINANCIAL DIVISION

systems within them in order to achieve order and efficiency, the staff were not rigidly type cast, nor were systems so inflexible to discourage initiative.

A.3 The Financial Division

The Financial Division shown in Figure 69, although not a large division numerically, has considerable influence within the company. It is controlled by a senior director and is responsible for the allocation of financial resources, the monitoring of cash flow, the profit margins on trading, the maintenance and payment of company records and accounts. Subordinate to the director, is the chief accountant, who also holds the position of the company secretary. The chief accountant is assisted by three assistant accountants, each acting in areas of special responsibility. These in turn are supported by six departments each controlled by a head of department. All payments made to and by the contractor are accounted within this division.

A.4 The Technical Division

The Technical Division, as in Figure 70 , is the largest and perhaps most influential division within the company.

Company directors are by definition concerned with directing policy and controlling activities within the company, establishing the aims and objectives of future developments,

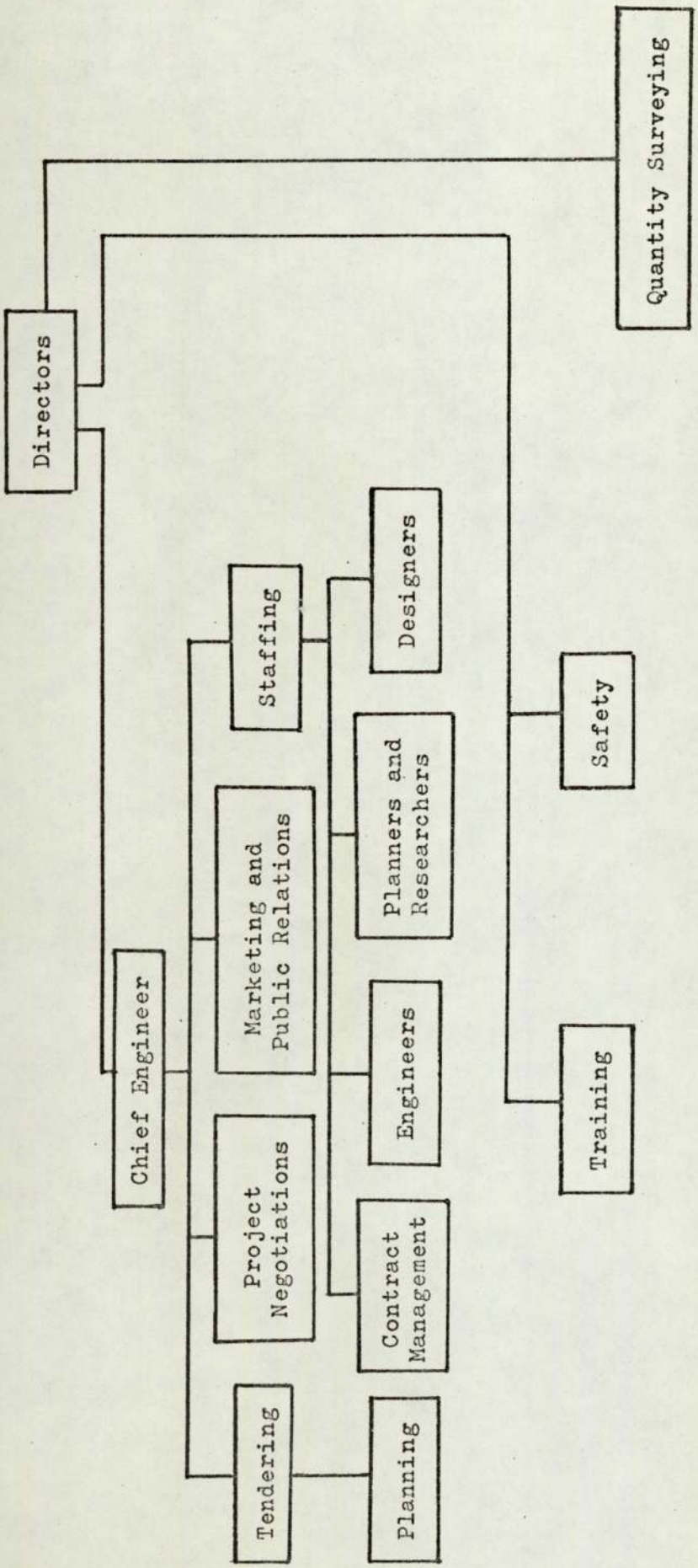

FIGURE 70

TECHNICAL DIVISION

and defining methods by which these objectives may be achieved in order to maximise profitability. In addition to these fundamental duties, eighteen of the twenty company directors are actively involved in the day to day operations of this division.

The Technical Division, see Figure 70 , although embracing many departments may be subdivided into six activities for ease and clarity of inspection. The first activity is concerned with obtaining contracts both by competition and negotiation, and consists of three departments, the Tender Department, the Planning Department and Project Negotiations.

The Tender Department is responsible for providing the tender - estimating function for the company, and to achieve this the department maintains detailed statistical records of information concerning tenders submitted, wage drifts and locational discrepancies, material and plant prices. Further it maintains information about competitors, the availability of future work and the trends in constructional activity.

The Planning Department is responsible for providing a service function to the Tender Department by designing temporary works, constructional programmes and producing method statements. To provide this service effectively it conducts research into methods of construction. The department also maintains a portfolio of information on new plant and equipment with statistics on manufactures performance ratings and those actually achieved by the company.

The Project Negotiations Department varies in activity according to the form of negotiation and the range and degree of finality of tender documents. The assistance of designers within the company may be required in addition to the back-up service provided by the planning department.

The second activity of the division is in marketing and public relations, and although numerically very small, a total of three persons, it must be recognised as a separate activity because of its speciality and independence of other activities within the division.

The third activity deals with the managerial control and staffing of the contracts undertaken by the company, and the provision of technical back-up services enabling management to perform its duties speedily and efficiently. The activity includes contract managers, mainly of director status, who are responsible for the overall co-ordination of contract efficiency; engineers, mainly responsible for site management; planners, providing the site management with initial programmes; analysis of plant and labour requirements and the detail of construction methods as the contract proceeds; site investigation and laboratory technicians, responsible for soil analysis, trial hole reports and the testing and sampling of materials; method study researchers, carrying out the essential day to day observation of productivity and control, and recording these observations in such a manner so as to be of direct benefit to the tender and planning departments; finally this activity includes architects, structural engineers, mechanical engineers, and electrical engineers.

The fourth activity is training. The training department is controlled by a senior director who is responsible for establishing and effecting a training policy for the company, both with respect to new and existing staff.

Current policy dictates that the staff must be kept informed of changing company policy and new procedures, they are kept up to date with developments within the industry. The department is also responsible for organising and implementing internal training programmes.

The fifth activity of safety, although based at the head office for administrative purposes, is concerned with site inspection of construction methods, and the use of plant and equipment to ensure that safety regulations are observed.

The sixth activity of the Technical Division is quantity surveying. This activity also occurs in the division of Site Management since the quantity surveying staff may be either office or site based.

The purpose of this activity is to agree and settle all payments due to the contractor both from the client, by way of interim payments, variations, increased costs of labour and material, dayworks, claims and the final account, and from domestic suppliers, sub-contractors, nominated suppliers and nominated sub-contractors for expense or loss incurred by the contractor by reason of error, omission or delay. Further, this activity agrees and settles all payments due from the contractor to sub-contractors, nominated suppliers and nominated

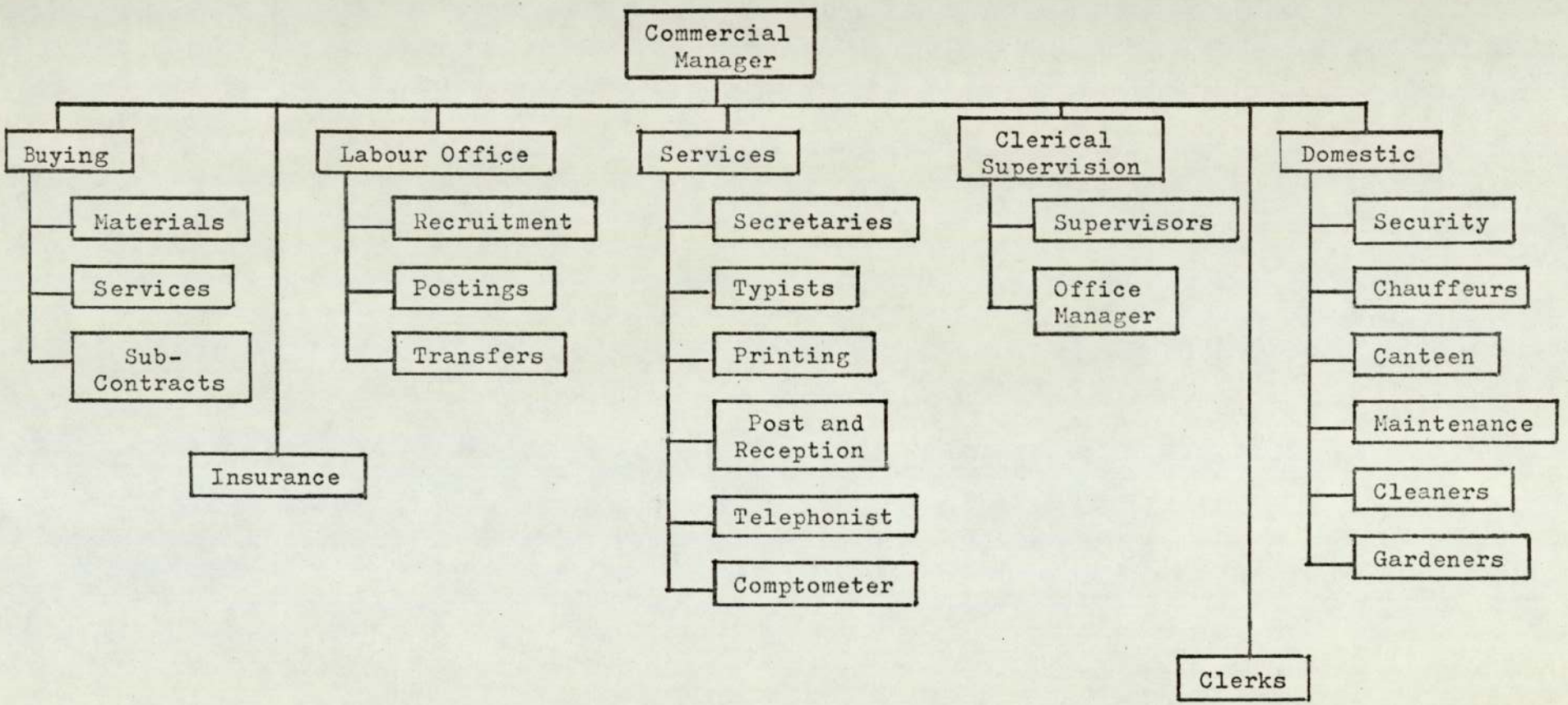

FIGURE 71

CLERICAL DIVISION

sub-contractors for interim payments, variations, increased costs of labour and material, dayworks, claims and the settlement of final accounts.

In addition to controlling payments to and made by the contractor, the activity plots income against expenditure to show cash flow, and the state of solvency for each contract.

A.5 The Clerical Division

The Clerical Division shown in Figure 71, provides an extensive range of services to all other divisions and activities within the company. The Buying Department is responsible for obtaining the correct material at the most favourable price, and co-ordinating the requirements of the site with the capacity of the supplier, to achieve a well balanced delivery at specified times. The Labour Office maintains records of all employees within the company, the contracts upon which each man is employed, the duration of the contracts, the movement and transfer of labour, and effects the necessary recruitment when shortage or difficulties occur. The Insurance Section effects and maintains all the insurance cover necessary for the establishment and construction projects.

A.6 The Resources Division

The Resources Division, Figure 72 , consists of plant control, land acquisition, mineral extraction and the control

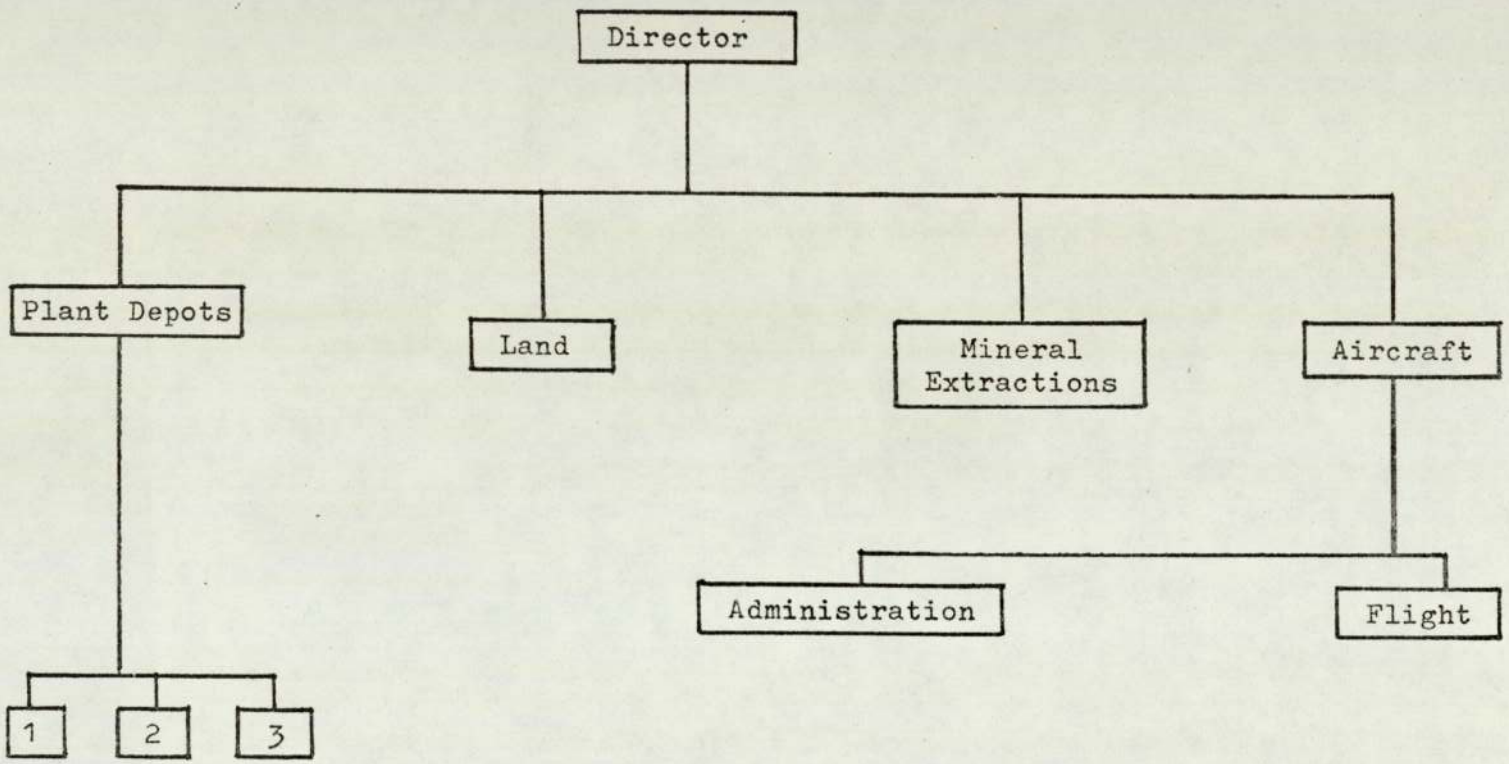

FIGURE 72

RESOURSES DIVISION

of the company aircraft. The plant control is responsible for the purchase and maintenance of all plant. In order that the company should have the benefit of modern, efficient machines, plant is sold at regular intervals and replaced by new equipment.

A land bank is maintained and extended at intervals to enable the speculative building programme developed by the company to be achieved.

The mineral extractions deals with the administrative procedures required to manage the company quarries and to develop the outlet industries for the raw material.

Finally the resources division control and administer the use of the company aircraft.

A.7 Site Administration

The fifth division, site administration, although clearly a division of the company, must be considered separately from the office divisions since the size and complexity of this organisation must vary according to the nature of the work, the length of the contract period and the likelihood of continuity contracts controlled from the same site office.

The detailed administrative structure shown in Figure 73 provides for definable parameters of responsibility and identifiable chains of command. This structure also represents

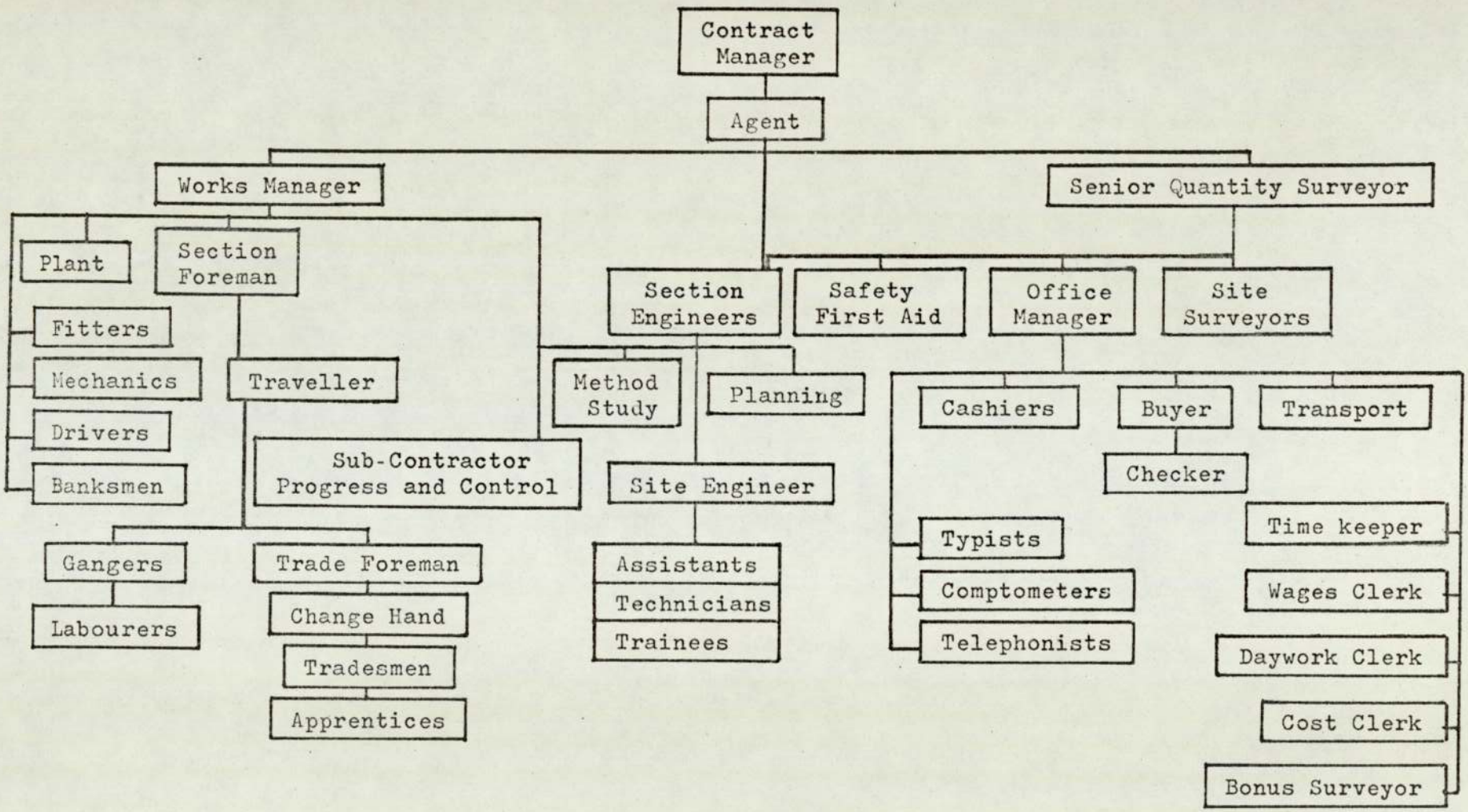

FIGURE 73

SITE ADMINISTRATION

the appointments and procedures followed on major contracts and would clearly be modified for smaller projects requiring less site management.

A P P E N D I X B

DEFINITIONS OF PROCEDURES

Tender Selection of Projects

Tender selection of projects shall mean the process by which a company's general management become sufficiently acquainted with the nature of a project so that they can make a well informed decision when replying to an invitation to tender.

Tender Estimating Planning

Tender estimating planning shall mean the calculation of the number of units of some or all of the resources which will be required to carry out the works, to relate these resources to a time scale and to the bill of quantities items to which they contribute costs.

Tender Estimating Pricing

Tender estimating pricing shall mean either establishing the cost rates for resources and assigning the resultant "costs" to the relevant bill of quantity items or using a unit rate which satisfactorily substitutes for this in order to establish

an estimate of the project costs.

Tender Marketing

Tender marketing shall mean adjusting the estimated prime cost total to a bid figure which optimally equates the likelihood of securing the contract to the desirability of being awarded it.

Production Planning

Production planning shall mean the overall phase and tactical analysis of the work to be executed, the selection of the construction methods to be used and the resources to be employed, the relating of the quantities of work, numbers of resources and time within a progressive co-ordinating and economic framework; all described in the programme.

Production Procurement

Production procurement shall mean the necessary action to ensure that the requisite type, number and quality of resources, e.g. data, labour, plant, sub-contracts, materials and capital, are actually available at the time required by the programme.

Production Progressing

Production progressing shall mean the procurement of resources and the executive action which authorises the expenditure or use of the gathered resources to produce the finished work.

Production Controlling

Production controlling shall mean the action of effecting the planned performance in production progress.

Payment to Main Contractor

Payment to main contractor shall mean all interim and final payments to the main contractor for executed work and materials on site.

Payments by Main Contractor

Payments by main contractor shall mean all payments made for executed work and materials on site and materials delivered.

APPENDIX C

DEFINITIONS OF INFORMATION PACKAGES

Information Package 1 -

Project Details. Project details shall mean information relating to the name of the client and the design team, the name of the project and the principal user functions, the number of blocks, structures, or sections within the contract, with overall dimensions of each block, structure or section.

Information Package 2 -

Site and Location. Site and location shall mean information relating to the geographical location of the site, the postal address, the means of access, restrictions relating to the possession of the site, matters concerning adjoining properties, the disposition of new and existing structures, the level of the water table, trial hole report and details of existing services and drains.

Information Package 3 -

Form of Contract. The form of contract shall mean type of contract, the headings of the conditions of contract and any ammendments to a standard form.

Information Package 4 -

Times and Phasing. Times and phasing shall mean information relating to possession and completion, details of phasing the completion, agreement on partial completion, procedures and phasing affecting production.

Information Package 5 -

Financial Details. The financial details shall mean information relating to liquidated and ascertained damages, the period of interim certificates, the period for honouring certificates, retentions, the type of contract - fixed price, fluctuations etc., provision of bond and dayworks.

Information Package 6 -

Statutory Details. Statutory details shall mean all matters imposing a statutory obligation, notices and fees, police regulations, and the use of explosives.

Information Package 7 -

Facilities and Services. Facilities and services shall mean all matters relating to temporary offices, storage accommodation and workshop facilities, temporary toilets, temporary gas, electricity and water, attendance on accommodation, temporary service for drying the works, cleaning the site and work on completion.

Information Package 8 -

General Responsibilities. General responsibilities shall mean the protection of the works, erection, maintenance and removal of hoardings and sign boards, and insurances.

Information Package 9 -

Material Specification. Material specification shall mean all information relating to standards and quality of material used in the work, such as British Standard Specifications, trade literature, and all information relating to mixes and/or strengths where materials are mixed together e.g. concrete and mortars.

Information Package 10 -

Workmanship. Workmanship shall mean the standards and performance of workmen, restrictions imposed upon the speed or method of production, the requirements of curing, drying and protection.

Information Package 11 -

Handling and Placing. Handling and placing shall mean all information relating to the care and protection of materials while being moved from one position to another such as off-loading, stacking, storing, distributing lifting and placing in position.

Information Package 12 -

Tests and Samples. Tests and samples shall mean those specific items required to satisfy the client or his representative on actual quality and/or consistency of materials and/or work.

Information Package 13 -

Locational Details. Locational details shall mean information identifying work with its point of inclusion in the structure, such as Sector, Block, Level or Room.

Information Package 14 -

Work Quantities. Work quantities shall mean the total quantity of measured work billed against each description item.

Information Package 15 -

Quantity Units. Quantity units shall mean the units in which work quantities are expressed either:- cube, super, linear, number or weight.

Information Package 16 -

Unit Rates. Unit rates shall mean the amount of money chargeable for completing one unit of work.

Information Package 17 -

Rate Extension. Rate extension shall mean the product of the unit rate multiplied by the work quantity.

Information Package 18 -

Extension Totals. Extension totals shall mean the sum of the rate extensions for each page of the bill of quantities.

Information Package 19 -

Work Descriptions. Work descriptions shall mean the written statement of the unit of work to be completed.

Information Package 20 -

Description Dimensions. Description dimensions shall mean those dimensions included in the work description to define the size of the unit of work. Generally it is necessary to know the length, width and height of each item.

Information Package 21 -

Provisional Quantities. Provisional quantities shall mean the measurement of work, the nature of which is uncertain in design or extent at the time of tendering

Information Package 21 - (continued)

and will be the subject of remeasurement in due course.

Information Package 22 -

Temporary Works. Temporary works shall mean work which must precede the actual building work. It may serve to retain external forces, support the construction work or provide access to the point of working.

Information Package 23 -

Demolitions. Demolitions, as part of the contract, shall mean pulling down, dismantling and removal of structures existing on the site at the commencement of the contract period.

Information Packages 24 and 25 -

Prime Cost Sums. Prime cost sum shall mean a sum provided for work or services to be executed by a nominated sub-contractor, a statutory authority or a public undertaking or for materials or goods to be obtained from a nominated supplier.

Information Package 26 -

Provisional Sums. Provisional sum shall mean a sum provided for work or for costs which cannot be entirely

Information Package 26 - (continued)

foreseen, defined or detailed at the time of tendering.

Information Package 27 -

Contingency. Contingency shall mean a sum provided for rectifying any unforeseen eventualities arising either on or off the site and shall not be included initially in respect of any specific item.

A P P E N D I X D

THE INTER-RELATIONSHIP OF TASKS

WITHIN PROCEDURES

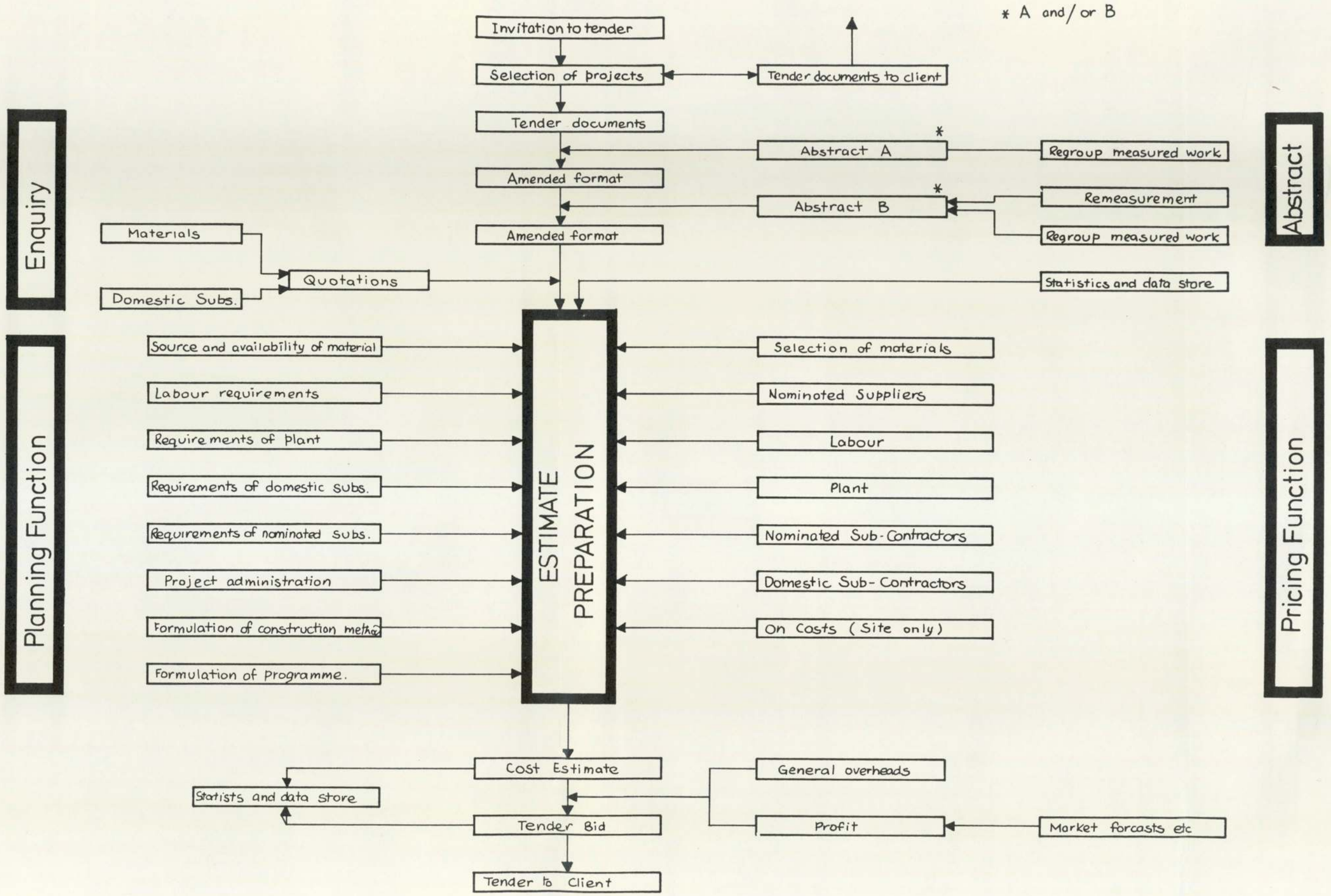

FIGURE 74
TENDERING

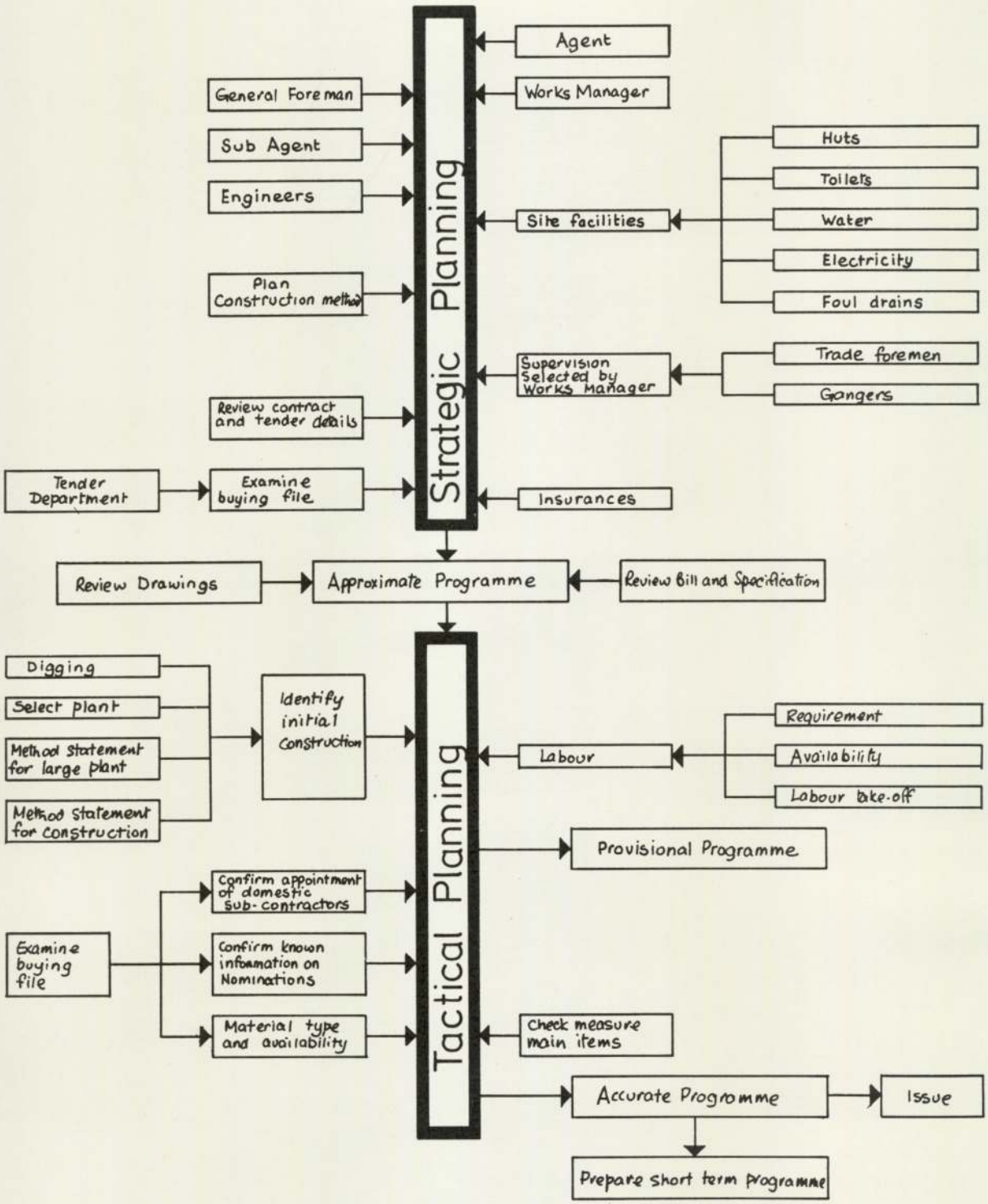

FIGURE 75
PLANNING

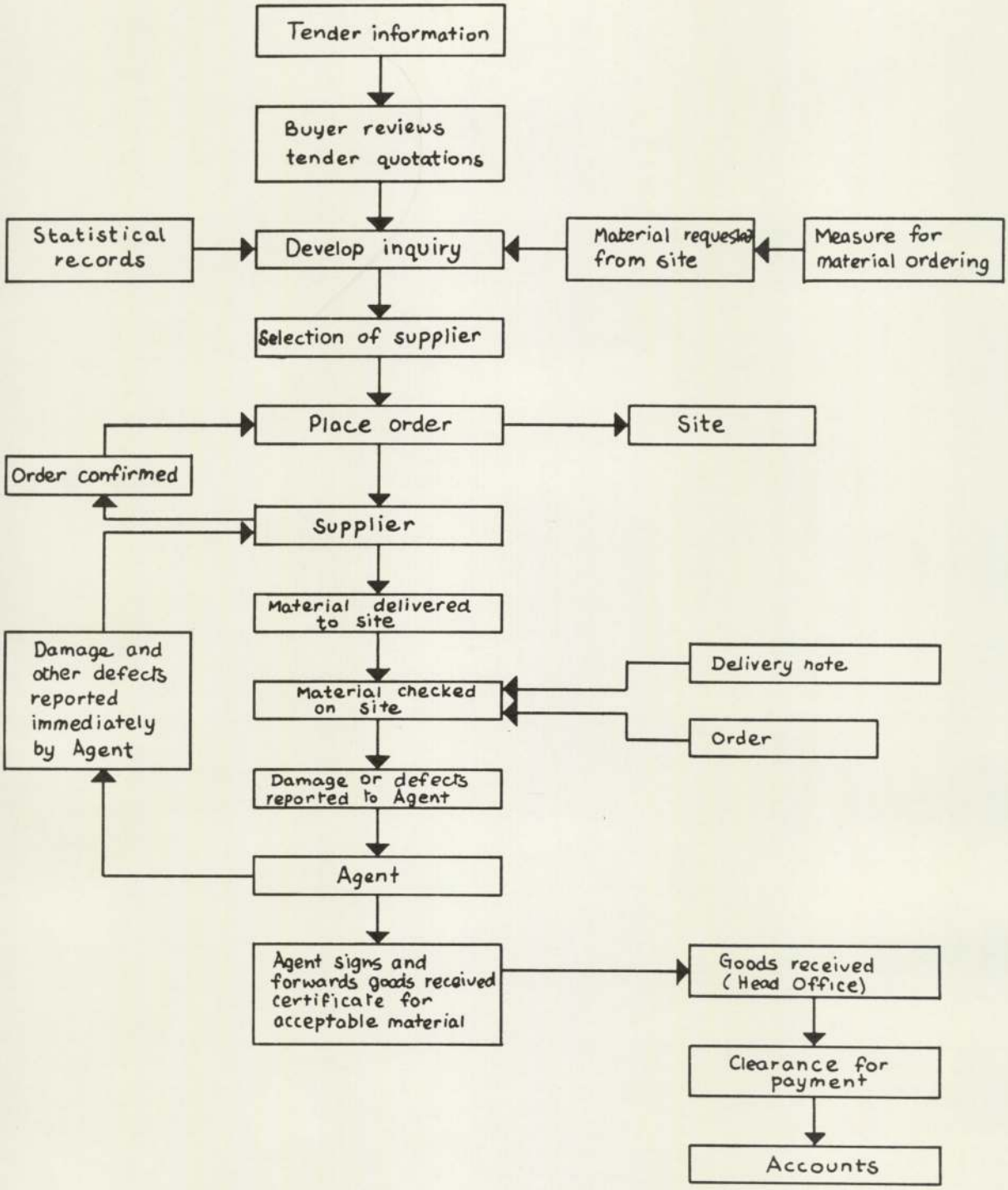

FIGURE 76
BUYING MATERIALS

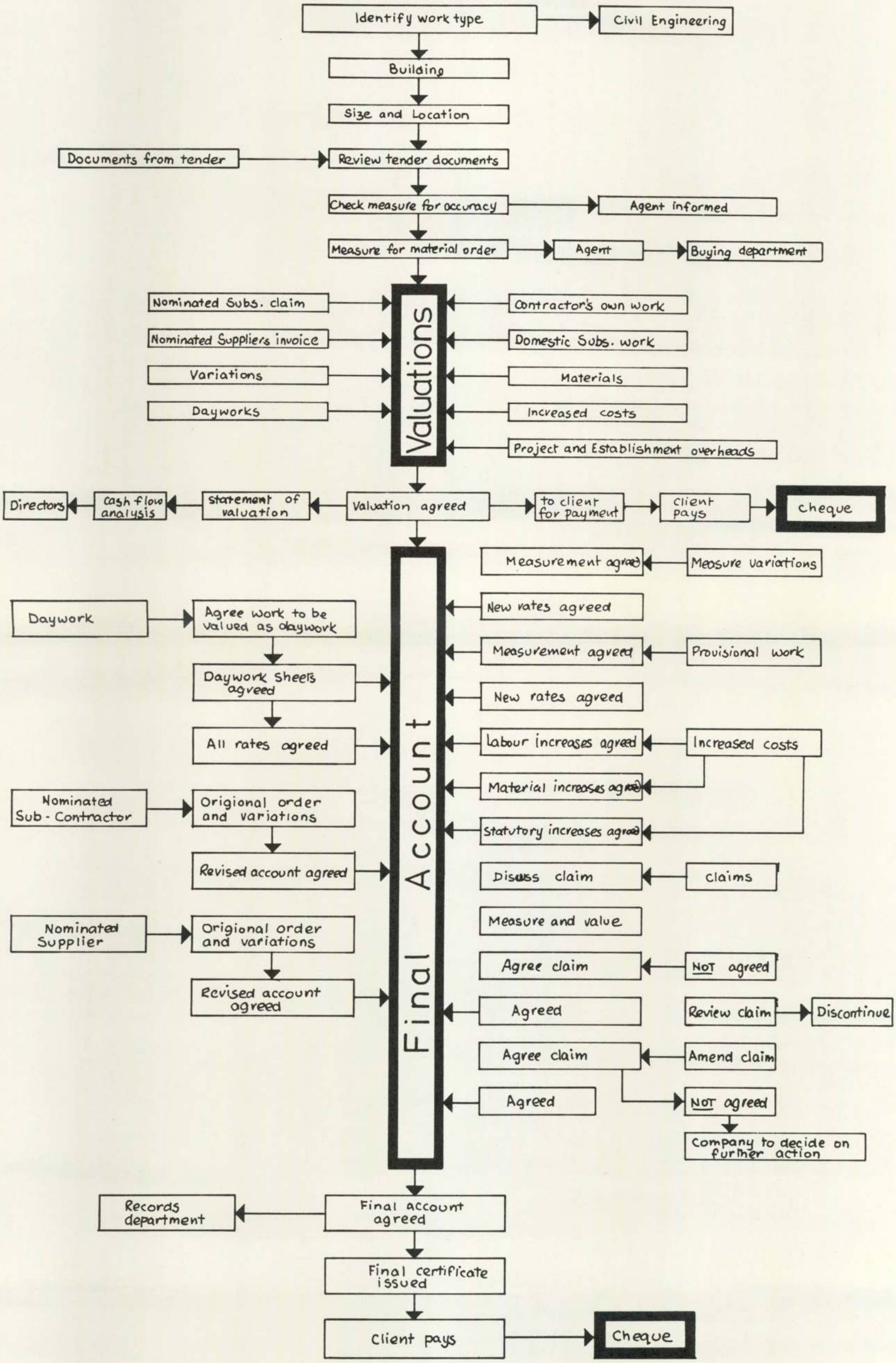

FIGURE 77
PAYMENT TO CONTRACTOR

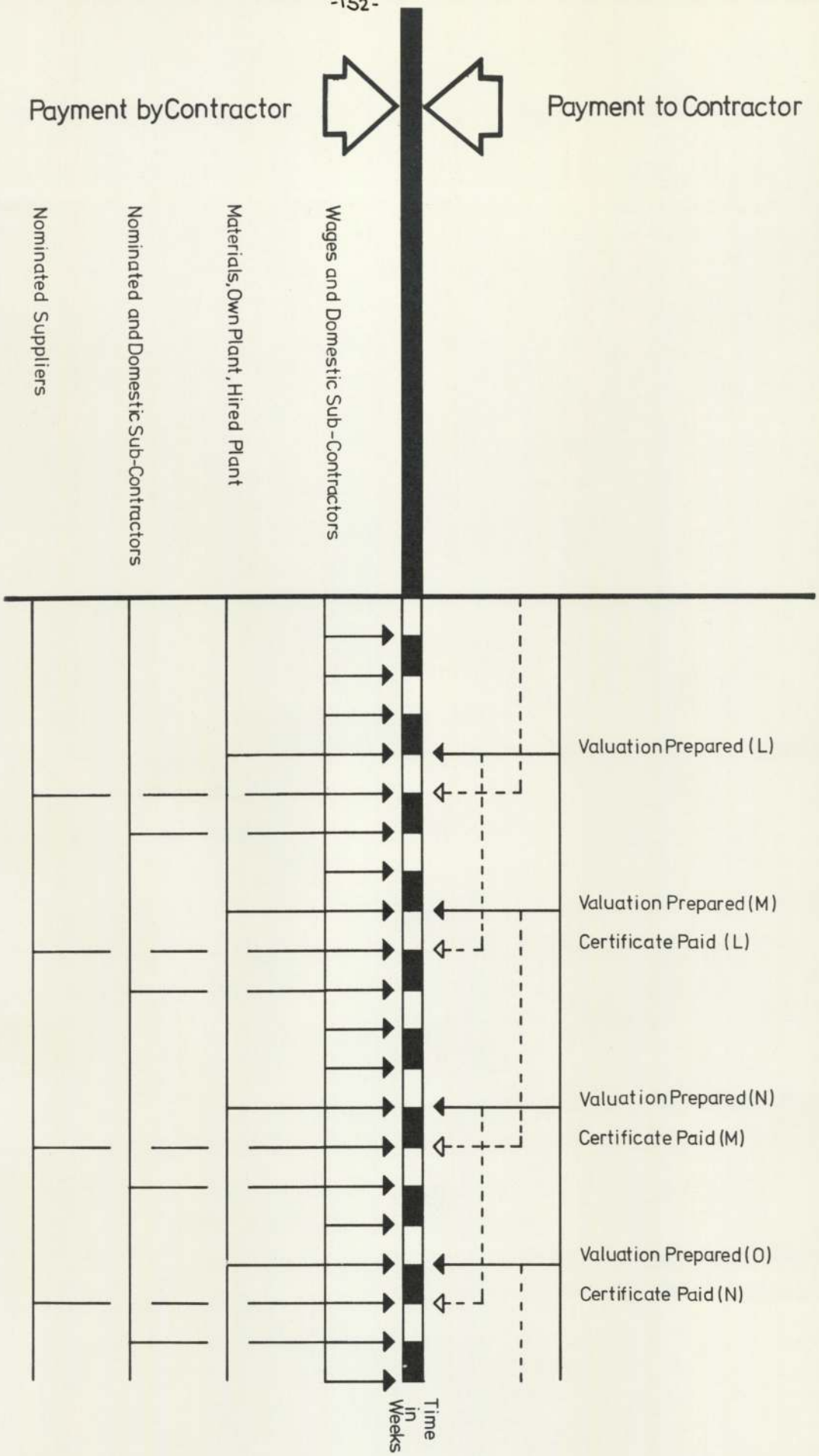

FIGURE 78

THE CYCLE OF PAYMENTS TO THE CONTRACTOR AND PAYMENTS BY THE CONTRACTOR

A P P E N D I X E

DATA SCHEDULES

OF

INFORMATION USED

Procedure 1

Tender Estimating Planning

NO.	Type of Information	Task 1 Materials and Nominated Suppliers	2 Labour	3 Plant	4 Nominated Sub-Contractors	5 Domestic Sub-Contractors	6 Project Overheads	7	8	9	10	11	12	13	14	15
1	Project details.		*	*		*	*									
2	Site and location.	*	*	*		*	*									
3	Form of contract.				*	*										
4	Times and phasing	*	*	*	*	*	*									
5	Financial details.															
6	Statutory details.	*	*	*	*	*	*									
7	Facilities and services.	*	*	*	*	*	*									
8	General responsibilities.	*	*	*	*	*	*									
9	Material specification.	*	*	*		*										
10	Workmanship.		*	*		*										
11	Handling and placing material.		*	*		*	*									
12	Tests and samples.	*				*										
13	Locational details.		*	*	*	*										
14	Work quantities.	*	*	*		*	*									
15	Quantity units.	*	*	*		*	*									
16	Unit rates.															
17	Rate extension.															
18	Extension totals.															
19	Work description	*	*	*	*	*	*									
20	Description dimensions	*	*	*	*	*	*									
21	Provisional quantities.	*	*	*		*	*									
22	Temporary works.	*	*	*		*	*									
23	Demolitions.	*	*	*		*	*									
24	P.C. Sums Nominated Suppliers.	*					*									
25	P.C. Sums Nominated Sub-Contractors.	*	*	*	*		*									
26	Provisional sums.						*									
27	Contingency.						*									

Procedure 2

Tender Estimating
Pricing

Type of

Information

No.	Type of Information	Task 1 Materials and Nominated Suppliers	2 Labour	3 Plant	4 Nominated Sub-Contracts	5 Domestic Sub-Contracts	6 Project Overheads	7 Establishment Overheads	8	9	10	11	12	13	14	15
1	Project details.		*	*		*	*	*								
2	Site and location.	*	*	*		*	*	*								
3	Form of contract.				*	*	*	*								
4	Times and phasing	*	*	*	*	*	*	*								
5	Financial details.	*	*	*	*	*	*	*								
6	Statutory details.	*	*	*	*	*	*	*								
7	Facilities and services.	*	*	*	*	*	*	*								
8	General responsibilities.	*	*	*	*	*	*	*								
9	Material specification.	*	*	*		*		*								
10	Workmanship.		*	*		*		*								
11	Handling and placing material.		*	*		*	*	*								
12	Tests and samples.	*	*			*		*								
13	Locational details.		*	*	*											
14	Work quantities.	*	*	*		*	*	*								
15	Quantity units.	*	*	*		*	*	*								
16	Unit rates.						*	*								
17	Rate extension.						*	*								
18	Extension totals.						*	*								
19	Work description	*	*	*	*		*	*								
20	Description dimensions	*	*	*	*	*	*	*								
21	Provisional quantities.	*	*	*		*	*	*								
22	Temporary works.	*	*	*		*	*	*								
23	Demolitions.	*	*	*		*	*	*								
24	P.C. Sums Nominated Suppliers.	*					*	*								
25	P.C. Sums Nominated Sub-Contractors.				*		*	*								
26	Provisional Sums.						*	*								
27	Contingency.															

Procedure 3

Production Planning

Strategic

Type of

Information

No.	Type of Information	Task 1 Appoint Agent, Work Manager & Gen./	2 Select Engineer & Sub-Agent. [F/man.	3 Select Site Facilities Reqd.	4 Plan Construction Method	5 Select Trade Foremen and Gangers	6 Review Contract Period & Tender Dtls.	7 Approximate Programme & Review Tender/	8 Examine Buying File & Review/ [Docs.	9 Insurances [Material Quots.	10	11	12	13	14	15
1	Project details.	*	*		*	*	*	*		*						
2	Site and location.	*	*		*	*	*	*	*	*						
3	Form of contract.						*									
4	Times and phasing	*	*		*	*	*	*	*	*						
5	Financial details.							*		*						
6	Statutory details.							*		*						
7	Facilities and services.			*	*			*		*						
8	General responsibilities.							*		*						
9	Material specification.				*			*	*							
10	Workmanship.				*			*	*							
11	Handling and placing material.				*			*	*							
12	Tests and samples.				*			*	*							
13	Locational details.				*			*	*							
14	Work quantities.				*	*		*	*							
15	Quantity units.				*	*		*	*							
16	Unit rates.				*	*		*	*							
17	Rate extension.				*	*		*	*							
18	Extension totals.				*	*		*	*							
19	Work description				*	*		*	*							
20	Description dimensions				*	*		*	*							
21	Provisional quantities.				*	*		*	*							
22	Temporary works.				*	*										
23	Demolitions.				*	*										
24	P.C. Sums Nominated Suppliers.				*	*	*									
25	P.C. Sums Nominated Sub-Contractors.				*	*	*									
26	Provisional Sums.				*	*	*									
27	Contingency.				*											

Procedure 4

Production Planning Tactical

Type of Information

NO.	Type of Information	Task 1 Identify Initial Construction & Select	2 Select Work for sub-letting [Con.	3 Check Measure Main Quantities of [Method.	4 [Work	5	6	7	8	9	10	11	12	13	14	15
1	Project details.	*	*	*												
2	Site and location.	*	*	*												
3	Form of contract.	*	*	*												
4	Times and phasing	*	*	*												
5	Financial details.	*	*	*												
6	Statutory details.	*		*												
7	Facilities and services.			*												
8	General responsibilities.	*	*	*												
9	Material specification.		*	*												
10	Workmanship.	*	*	*												
11	Handling and placing material.	*	*	*												
12	Tests and samples.		*													
13	Locational details.	*	*	*												
14	Work quantities.	*	*	*												
15	Quantity units.	*	*	*												
16	Unit rates.	*	*	*												
17	Rate extension.		*	*												
18	Extension totals.		*	*												
19	Work description	*	*	*												
20	Description dimensions	*	*	*												
21	Provisional quantities.	*	*	*												
22	Temporary works.	*	*	*												
23	Demolitions.	*	*	*												
24	P.C. Sums Nominated Suppliers.															
25	P.C. Sums Nominated Sub-Contractors.															
26	Provisional Sums.															
27	Contingency.															

Procedure 5

Production Procurement Plant

No.	Type of Information	Task 1: Select Plant & Prepare Method/ Procure Plant	Task 2: Statement
1	Project details.	*	
2	Site and location.	*	*
3	Form of contract.	*	
4	Times and phasing	*	
5	Financial details.	*	
6	Statutory details.	*	*
7	Facilities and services.		*
8	General responsibilities.	*	
9	Material specification.	*	
10	Workmanship.		
11	Handling and placing material.	*	
12	Tests and samples.	*	
13	Locational details.		
14	Work quantities.	*	
15	Quantity units.	*	*
16	Unit rates.	*	*
17	Rate extension.	*	
18	Extension totals.		
19	Work description		
20	Description dimensions	*	*
21	Provisional quantities.	*	*
22	Temporary works.	*	
23	Demolitions.	*	
24	P.C. Sums Nominated Suppliers.		
25	P.C. Sums Nominated Sub-Contractors.		
26	Provisional Sums.		
27	Contingency.		

Procedure 6

Production Procurement

Materials

NO.	Type of Information	Task 1 Measure for Materials Ordering	2 Review Tender Documents & Quotations	3 Develop Enquiry	4	5	6	7	8	9	10	11	12	13	14	15
1	Project details.		*	*												
2	Site and location.		*	*												
3	Form of contract.		*	*												
4	Times and phasing	*	*	*												
5	Financial details.		*	*												
6	Statutory details.		*	*												
7	Facilities and services.															
8	General responsibilities.															
9	Material specification.	*	*	*												
10	Workmanship.		*	*												
11	Handling and placing material.		*	*												
12	Tests and samples.		*	*												
13	Locational details.	*	*	*												
14	Work quantities.	*	*	*												
15	Quantity units.	*	*	*												
16	Unit rates.		*	*												
17	Rate extension.		*	*												
18	Extension totals.		*	*												
19	Work description	*	*	*												
20	Description dimensions	*	*	*												
21	Provisional quantities.		*	*												
22	Temporary works.	*	*	*												
23	Demolitions.		*													
24	P.C. Sums Nominated Suppliers.															
25	P.C. Sums Nominated Sub-Contractors.															
26	Provisional Sums.															
27	Contingency.															

Procedure 7

Production Procurement

Domestic Sub-Contractors

NO.	Type of Information	Task 1 Decision to Sub-Contract	2 Review Tender Documents & Quotations	3 Develop Enquiry	4	5	6	7	8	9	10	11	12	13	14	15
1	Project details.	*	*	*												
2	Site and location.	*	*	*												
3	Form of contract.	*	*	*												
4	Times and phasing	*	*	*												
5	Financial details.	*	*	*												
6	Statutory details.	*	*	*												
7	Facilities and services.	*	*	*												
8	General responsibilities.	*	*	*												
9	Material specification.	*	*	*												
10	Workmanship.	*	*	*												
11	Handling and placing material.	*	*	*												
12	Tests and samples.	*	*	*												
13	Locational details.	*	*	*												
14	Work quantities.	*	*	*												
15	Quantity units.	*	*	*												
16	Unit rates.	*	*	*												
17	Rate extension.	*	*	*												
18	Extension totals.	*	*	*												
19	Work description	*	*	*												
20	Description dimensions	*	*	*												
21	Provisional quantities.	*	*	*												
22	Temporary works.	*	*	*												
23	Demolitions.	*	*	*												
24	P.C. Sums Nominated Suppliers.	*														
25	P.C. Sums Nominated Sub-Contractors.	*														
26	Provisional sums.															
27	Contingency															

Procedure 8

Production Procurement of Nominated Sub-Contractors and Suppliers

NO.	Type of Information	Task 1: Review Tender Documents	Task 2: Selection of Sub-Contractor/Supplier
1	Project details.	*	*
2	Site and location.	*	*
3	Form of contract.	*	*
4	Times and phasing	*	*
5	Financial details.	*	*
6	Statutory details.	*	*
7	Facilities and services.		
8	General responsibilities.		
9	Material specification.	*	*
10	Workmanship.	*	*
11	Handling and placing material.	*	*
12	Tests and samples.	*	*
13	Locational details.	*	*
14	Work quantities.	*	*
15	Quantity units.	*	*
16	Unit rates.	*	*
17	Rate extension.	*	*
18	Extension totals.	*	*
19	Work description	*	*
20	Description dimensions	*	*
21	Provisional quantities.	*	*
22	Temporary works.		
23	Demolitions.		
24	P.C. Sums Nominated Suppliers.	*	*
25	P.C. Sums Nominated Sub-Contractors.	*	*
26	Provisional Sums.		
27	Contingency.		

Procedure 9

Production Progressing Off Site Manufacture and Delivery

Type of Information

NO.		Task: Off Site Manufacture and Delivery	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Project details.																
2	Site and location.	*															
3	Form of contract.																
4	Times and phasing																
5	Financial details.																
6	Statutory details.																
7	Facilities and services.																
8	General responsibilities.																
9	Material specification.	*															
10	Workmanship.	*															
11	Handling and placing material.	*															
12	Tests and samples.	*															
13	Locational details.	*															
14	Work quantities.	*															
15	Quantity units.	*															
16	Unit rates.																
17	Rate extension.																
18	Extension totals.																
19	Work description	*															
20	Description dimensions	*															
21	Provisional quantities.	*															
22	Temporary works.																
23	Demolitions.																
24	P.c. Sums Nominated Suppliers.																
25	P.c. Sums Nominated Sub-Contractors.																
26	Provisional sums.																
27	Contingency.																

Procedure 10

Production Progressing

On Site Manufacture

Type of Information

NO.	Type of Information	Task: On Site Manufacture 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Project details.															
2	Site and location.															
3	Form of contract.															
4	Times and phasing															
5	Financial details.															
6	Statutory details.															
7	Facilities and services.															
8	General responsibilities.															
9	Material specification.	*														
10	Workmanship.	*														
11	Handling and placing material.	*														
12	Tests and samples.	*														
13	Locational details.	*														
14	Work quantities.	*														
15	Quantity units.	*														
16	Unit rates.															
17	Rate extension.															
18	Extension totals.															
19	Work description	*														
20	Description dimensions	*														
21	Provisional quantities.	*														
22	Temporary works.															
23	Demolitions.															
24	P.C. Sums Nominated Suppliers.															
25	P.C. Sums Nominated Sub-Contractors.															
26	Provisional Sums.															
27	Contingency.															

Procedure 11

Production Progressing

On Site Distribution

NO.	Type of Information	Task 1 On Site Distribution	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Project details.															
2	Site and location.															
3	Form of contract.															
4	Times and phasing															
5	Financial details.															
6	Statutory details.															
7	Facilities and services.															
8	General responsibilities.															
9	Material specification.															
10	Workmanship.															
11	Handling and placing material.	*														
12	Tests and samples.															
13	Locational details.															
14	Work quantities.															
15	Quantity units.															
16	Unit rates.															
17	Rate extension.															
18	Extension totals.															
19	Work description															
20	Description dimensions															
21	Provisional quantities.															
22	Temporary works.															
23	Demolitions.															
24	P.C. Sums Nominated Suppliers.															
25	P.C. Sums Nominated Sub-Contractors.															
26	Provisional sums.															
27	Contingency.															

Procedure 12

Production Controlling Quality

Type of Information

NO.	Type of Information	Task 1: Controlling Quality of Materials and/or Work/ship.
1	Project details.	
2	Site and location.	
3	Form of contract.	
4	Times and phasing	
5	Financial details.	
6	Statutory details.	
7	Facilities and services.	
8	General responsibilities.	
9	Material specification.	*
10	Workmanship.	*
11	Handling and placing material.	*
12	Tests and samples.	*
13	Locational details.	
14	Work quantities.	
15	Quantity units.	
16	Unit rates.	
17	Rate extension.	
18	Extension totals.	
19	Work description	
20	Description dimensions	
21	Provisional quantities.	
22	Temporary works.	
23	Demolitions.	
24	P.C. Sums Nominated Suppliers.	
25	P.C. Sums Nominated Sub-Contractors.	
26	Provisional sums.	
27	Contingency.	

Task: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Procedure 13

Production Payment to Main Contractor

No.	Type of Information	Task 1: Identification of Type of Construction/Work	Task 2: Size and Location of Contract	Task 3: Review Tender Documents	Task 4: Prepare Interim Valuations	Task 5: Remeasure Variation Orders	Task 6: Prepare Dayworks	Task 7: Calculate Increased Costs	Task 8: Prepare Domestic Sub-Contractors A/cs.	Task 9: Prepare Nominated Suppliers & Subs./A/cs.	Task 10: Calculate Claims	Task 11	Task 12	Task 13	Task 14	Task 15
1	Project details.	*	*	*	*	*										
2	Site and location.	*	*	*		*	*		*		*					
3	Form of contract.	*		*	*	*			*	*	*					
4	Times and phasing		*					*	*	*	*					
5	Financial details.			*	*		*	*	*	*	*					
6	Statutory details.			*							*					
7	Facilities and services.		*		*	*	*		*		*					
8	General responsibilities.										*					
9	Material specification.					*	*	*								
10	Workmanship.								*	*	*					
11	Handling and placing material.					*	*		*	*	*					
12	Tests and samples.						*		*		*					
13	Locational details.				*	*										
14	Work quantities.				*	*		*								
15	Quantity units.				*	*		*	*							
16	Unit rates.				*	*			*							
17	Rate extension.				*	*			*							
18	Extension totals.				*				*							
19	Work description				*	*										
20	Description dimensions				*	*			*							
21	Provisional quantities.				*											
22	Temporary works.			*	*	*										
23	Demolitions.				*	*			*	*	*					
24	P.c. Sums Nominated Suppliers.		*		*	*	*			*	*					
25	P.c. Sums Nominated Sub-Contractors.		*		*	*	*			*	*					
26	Provisional sums.						*									
27	Contingency.						*									

Procedure 14

Production Payment by

Main Contractor

Type of

Information

NO.		Task 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Invoice R'cd. & A/c.Pd.for Materials	Invoice Regd. for Domestic Sub-contractors	Prepare Measurements & Agree A/cs.for [dom.subs.	A/cs.& Invoices for Nominated Suppliers [& Subs.	Measure & Agree A/cs. for [Nominated supp.&Subs.										
1	Project details.	*	*		*	*										
2	Site and location.	*	*	*	*	*										
3	Form of contract.		*	*	*	*										
4	Times and phasing			*	*	*										
5	Financial details.	*	*	*	*	*										
6	Statutory details.															
7	Facilities and services.			*		*										
8	General responsibilities.															
9	Material specification.	*		*												
10	Workmanship.			*												
11	Handling and placing material.			*		*										
12	Tests and samples.			*												
13	Locational details.	*														
14	Work quantities.		*	*												
15	Quantity units.	*	*	*												
16	Unit rates.		*	*												
17	Rate extension.		*	*												
18	Extension totals.		*	*												
19	Work description		*	*												
20	Description dimensions		*	*												
21	Provisional quantities.															
22	Temporary works.															
23	Demolitions.			*												
24	P.C. Sums Nominated Suppliers.				*	*										
25	P.C. Sums Nominated Sub-Contractors.				*	*										
26	Provisional sums.															
27	Contingency.															

A P P E N D I X F

SAMPLE OF SUFFICIENCY AND ACCURACY

DATA SCHEDULES

Task:- Procedure 1 - Tender Estimating Planning
Materials and Nominated Suppliers

No	Usefulness of Information	Sufficiency				Accuracy			
		1	2	3	4	1	2	3	4
		Self supporting	Read with other client documents.	Read with contractors documents.	Read with external documents	Information accurate and in useable format.	Information accurate - format requires revision.	Information inaccurate - but in useable format.	Information inaccurate and format unusable.
1	Project details.		*			*			
2	Site and location.		*			*			
3	Form of contract.		*			*			
4	Times and phasing.		*		*	*			
5	Financial details.		*			*			
6	Statutory details.		*			*			
7	Facilities and services.		*			*			
8	General responsibilities.		*			*			
9	Material specification.		*			*			
10	Workmanship.								
11	Handling and placing material.								
12	Tests and samples.	*				*			
13	Locational details.								
14	Work quantities.		*				*		
15	Quantity units.	*					*		
16	Unit rates.								
17	Rate extension.								
18	Extension totals.	*							
19	Work description.						*		
20	Description dimensions.	*				*			
21	Provisional quantities.	*				*			
22	Temporary works.			*			*		
23	Demolitions.		*				*		
24	Pc. Sums Nominated Suppliers.	*				*			
25	Pc. Sums Nominated Sub-Contractors	*				*			
26	Provisional sums.								
27	Contingency.								

Task:- Procedure 1 - Tender Estimating Planning Labour

No	Usefulness of Information	Sufficiency				Accuracy			
		1 Self supporting	2 Read with other client documents.	3 Read with contractors documents.	4 Read with external documents.	1 Information accurate and in useable format.	2 Information accurate - format requires revision.	3 Information inaccurate - but in useable format.	4 Information inaccurate and format unusable.
1	Project details.		*			*			
2	Site and location.		*			*			
3	Form of contract.		*			*			
4	Times and phasing.		*			*			
5	Financial details.		*			*			
6	Statutory details.		*			*			
7	Facilities and services.		*			*			
8	General responsibilities.		*			*			
9	Material specification.		*			*			
10	Workmanship.		*			*			
11	Handling and placing material.		*			*			
12	Tests and samples.								
13	Locational details.		*			*			
14	Work quantities.		*			*			
15	Quantity units.	*				*			
16	Unit rates.								
17	Rate extension.								
18	Extension totals.								
19	Work description.	*				*			
20	Description dimensions.	*				*			
21	Provisional quantities.	*				*			
22	Temporary works.			*		*			
23	Demolitions.		*			*			
24	Pc. Sums Nominated Suppliers.								
25	Pc. Sums Nominated Sub-Contractors.	*				*			
26	Provisional sums.								
27	Contingency.								

Task:- Procedure 1 - Tender Estimating Planning Plant

No	Usefulness of Information	Sufficiency				Accuracy			
		1 Self supporting	2 Read with other client documents.	3 Read with contractors documents.	4 Read with external documents	1 Information accurate and in useable format.	2 Information accurate - format requires revision	3 Information inaccurate - but in usable format.	4 Information inaccurate and format unusable.
1	Project details.		*			*			
2	Site and location.		*			*			
3	Form of contract.								
4	Times and phasing.		*			*			
5	Financial details.								
6	Statutory details.				*	*			
7	Facilities and services.		*			*			
8	General responsibilities.		*			*			
9	Material specification.		*			*			
10	Workmanship.		*			*			
11	Handling and placing material.		*			*			
12	Tests and samples.								
13	Locational details.		*			*			
14	Work quantities.		*			*			
15	Quantity units.	*				*			
16	Unit rates.								
17	Rate extension.								
18	Extension totals.								
19	Work description.	*				*			
20	Description dimensions.	*				*			
21	Provisional quantities.	*				*			
22	Temporary works.			*		*			
23	Demolitions.		*			*			
24	Pc. Sums Nominated Suppliers.								
25	Pc. Sums Nominated Sub-Contractors	*				*			
26	Provisional sums.								
27	Contingency.								

Task:- Procedure 1 - Tender Estimating Planning
Nominated Sub-Contracts

No	Usefulness of Information	Sufficiency				Accuracy			
		1	2	3	4	1	2	3	4
		Self supporting	Read with other client documents.	Read with contractors documents.	Read with external documents.	Information accurate and in useable format.	Information accurate - format requires revision.	Information inaccurate - but in useable format.	Information inaccurate and format unusable.
1	Project details.								
2	Site and location.								
3	Form of contract.		*			*			
4	Times and phasing.		*			*			
5	Financial details.								
6	Statutory details.				*	*			
7	Facilities and services.		*			*			
8	General responsibilities.		*			*			
9	Material specification.								
10	Workmanship.								
11	Handling and placing material.								
12	Tests and samples.								
13	Locational details.		*			*			
14	Work quantities.								
15	Quantity units.								
16	Unit rates.								
17	Rate extension.								
18	Extension totals.								
19	Work description.	*				*			
20	Description dimensions.	*				*			
21	Provisional quantities.								
22	Temporary works.								
23	Demolitions.								
24	Pc. Sums Nominated Suppliers.								
25	Pc. Sums Nominated Sub-Contractors	*				*			
26	Provisional sums.								
27	Contingency.								

Task:- Procedure 1 - Tender Estimating Planning
Domestic Sub-Contractors

No	Usefulness of Information	Sufficiency				Accuracy			
		1 Self supporting	2 Read with other client documents.	3 Read with contractors documents.	4 Read with external documents.	1 Information accurate and in useable format.	2 Information accurate - format requires revision	3 Information inaccurate - but in usable format.	4 Information inaccurate and format unusable.
1	Project details.		*			*			
2	Site and location.		*			*			
3	Form of contract.		*			*			
4	Times and phasing.		*			*			
5	Financial details.		*			*			
6	Statutory details.		*			*			
7	Facilities and services.		*			*			
8	General responsibilities.		*			*			
9	Material specification.		*			*			
10	Workmanship.		*			*			
11	Handling and placing material.		*			*			
12	Tests and samples.	*				*			
13	Locational details.		*			*			
14	Work quantities.		*			*			
15	Quantity units.	*				*			
16	Unit rates.								
17	Rate extension.								
18	Extension totals.								
19	Work description.	*				*			
20	Description dimensions.	*				*			
21	Provisional quantities.	*				*			
22	Temporary works.			*		*			
23	Demolitions.		*			*			
24	Pc. Sums Nominated Suppliers.								
25	Pc. Sums Nominated Sub-Contractors.								
26	Provisional sums.								
27	Contingency.								

Task:- Procedure 1 - Tender Estimating Planning
Project Overheads

No	Usefulness of Information	Sufficiency				Accuracy			
		1 Self supporting	2 Read with other client documents.	3 Read with contractors documents.	4 Read with external documents.	1 Information accurate and in useable format.	2 Information accurate - format requires revision.	3 Information inaccurate - but in useable format.	4 Information inaccurate and format unusable.
1	Project details.		*			*			
2	Site and location.			*			*		
3	Form of contract.								
4	Times and phasing.			*			*		
5	Financial details.								
6	Statutory details.		*			*			
7	Facilities and services.		*			*			
8	General responsibilities.		*			*			
9	Material specification.								
10	Workmanship.								
11	Handling and placing material.			*			*		
12	Tests and samples.								
13	Locational details.								
14	Work quantities.			*			*		
15	Quantity units.			*			*		
16	Unit rates.								
17	Rate extension.								
18	Extension totals.								
19	Work description.			*			*		
20	Description dimensions.			*			*		
21	Provisional quantities.			*			*		
22	Temporary works.			*			*		
23	Demolitions.			*			*		
24	Pc. Sums Nominated Suppliers.	*				*			
25	Pc. Sums Nominated Sub-Contractors	*				*			
26	Provisional sums.	*				*			
27	Contingency.	*				*			

A P P E N D I X G

SAMPLE COMPUTER ANALYSIS

PRINTOUT

PROCEDURE NO 13

NO OF TASKS = 10

	1	2	3	4	5	6	7	8	9	10
INF.PACK.NO 1	2112	2112		1116	1116				1116	3304
INF.PACK.NO 2	2112	2112	2209		3304	3304		3108		3304
INF.PACK.NO 3	1116		1116	1116	1116			3108	3108	3304
INF.PACK.NO 4		1116					2112	3108		3304
INF.PACK.NO 5			1116	1116		1116	1116	3108	1116	3304
INF.PACK.NO 6			2209							3304
INF.PACK.NO 7		2209		1116	1116	1116		3206	1116	3304
INF.PACK.NO 8										3304
INF.PACK.NO 9					1116	2209	1116	1116		3304
INF.PACK.NO 10								1116		3304
INF.PACK.NO 11					3304	2403		1116	1116	3304
INF.PACK.NO 12						2112		1116		3304
INF.PACK.NO 13				1116	1116					3304
INF.PACK.NO 14				3304	2112		1116			3304
INF.PACK.NO 15				1116	1116		1116	1116		3304
INF.PACK.NO 16				1116	1116			1116		3304
INF.PACK.NO 17				1116				1116		3304
INF.PACK.NO 18				1116				1116		3304
INF.PACK.NO 19				1116	2306			1116		3304
INF.PACK.NO 20				1116	2306			1116		3304
INF.PACK.NO 21				1116						3304
INF.PACK.NO 22			2209	2209	2306					3304
INF.PACK.NO 23				2209	2306			2306	1116	3304
INF.PACK.NO 24		1116		2209	2209	3402			2209	3304
INF.PACK.NO 25		1116		2209	2209	3402			2209	3304
INF.PACK.NO 26						2403				
INF.PACK.NO 27						2403				

SCORE TOTALS

INFO.PACK.TOTALS	40	81	59	232	174	70	76	204	106	100
INFO.PACK. 1- 8	40	49	50	64	52	36	28	38	56	32
INFO.PACK. 9-12	0	0	0	0	20	24	16	64	16	16
INFO.PACK. 13-23	0	0	9	150	84	0	32	102	16	44
INFO.PACK. 24-27	0	32	0	18	18	10	0	0	18	8

OCCUR TOTALS

INFO.USES.TOTALS	3	6	5	17	16	10	5	16	8	25
INFO.USES. 1- 8	3	4	4	4	4	3	2	5	4	8
INFO.USES. 9-12	0	0	0	0	2	3	1	4	1	4
INFO.USES. 13-23	0	0	1	11	8	0	2	7	1	11
INFO.USES. 24-27	0	2	0	2	2	4	0	0	2	2

S 1	1	1	3	2	12	7	2	4	10	5	0
	2	1	1	2	4	3	2	1	0	3	0
	3	0	0	0	0	1	0	1	4	1	0
	4	0	0	0	8	3	0	2	6	1	0
	5	0	2	0	0	0	0	0	0	0	0
S 2	1	2	3	3	4	7	5	1	1	2	0
	2	2	3	2	0	0	0	1	0	0	0
	3	0	0	0	0	0	3	0	0	0	0
	4	0	0	1	2	5	0	0	1	0	0
	5	0	0	0	2	2	2	0	0	2	0
S 3	1	0	0	0	1	2	3	0	5	1	25
	2	0	0	0	0	1	1	0	5	1	8
	3	0	0	0	0	1	0	0	0	0	4
	4	0	0	0	1	0	0	0	0	0	11
	5	0	0	0	0	0	2	0	0	0	2
S 4	1	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0

A 1	1	3	5	2	12	8	3	5	14	6	0
	2	3	3	2	4	3	2	2	4	4	0
	3	0	0	0	0	1	1	1	4	1	0
	4	0	0	0	8	4	0	2	6	1	0
	5	0	2	0	0	0	0	0	0	0	0
A 2	1	0	1	3	4	2	1	0	1	2	0
	2	0	1	2	0	0	0	0	1	0	0
	3	0	0	0	0	0	1	0	0	0	0
	4	0	0	1	2	0	0	0	0	0	0
	5	0	0	0	2	2	0	0	0	2	0
A 3	1	0	0	0	1	6	1	0	1	0	25
	2	0	0	0	0	1	1	0	0	0	8
	3	0	0	0	0	1	0	0	0	0	4
	4	0	0	0	1	4	0	0	1	0	11
	5	0	0	0	0	0	0	0	0	0	2
A 4	1	0	0	0	0	0	5	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	1	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	4	0	0	0	0

PROCEDURE NO 13

	S 1	S 2	S 3	S 4	A 1	A 2	A 3	A 4	IU	USE	IUPC	USEPC
INF.PACK.NO 1	5	2	1	0	5	0	1	0	76	6	79	60
INF.PACK.NO 2	0	3	4	0	3	1	3	0	53	7	47	70
INF.PACK.NO 3	4	0	3	0	6	0	1	0	84	7	75	70
INF.PACK.NO 4	1	1	2	0	3	0	1	0	40	4	62	40
INF.PACK.NO 5	5	0	2	0	6	0	1	0	92	7	82	70
INF.PACK.NO 6	0	1	1	0	0	1	1	0	13	2	41	20
INF.PACK.NO 7	4	1	2	0	4	2	1	0	83	7	74	70
INF.PACK.NO 8	0	0	1	0	0	0	1	0	4	1	25	10
INF.PACK.NO 9	5	1	1	0	3	1	1	0	61	5	76	50
INF.PACK.NO 10	1	0	1	0	1	0	1	0	20	2	62	20
INF.PACK.NO 11	2	1	2	0	2	0	2	1	43	5	54	50
INF.PACK.NO 12	1	1	1	0	2	0	1	0	32	3	67	30
INF.PACK.NO 13	2	0	1	0	2	0	1	0	36	3	75	30
INF.PACK.NO 14	1	1	2	0	2	0	2	0	36	4	56	40
INF.PACK.NO 15	4	0	1	0	4	0	1	0	68	5	85	50
INF.PACK.NO 16	5	0	1	0	3	0	1	0	52	4	81	40
INF.PACK.NO 17	2	0	1	0	2	0	1	0	36	3	75	30
INF.PACK.NO 18	2	0	1	0	2	0	1	0	36	3	75	30
INF.PACK.NO 19	2	1	1	0	2	0	2	0	42	4	66	40
INF.PACK.NO 20	2	1	1	0	2	0	2	0	42	4	66	40
INF.PACK.NO 21	1	0	1	0	1	0	1	0	20	2	62	20
INF.PACK.NO 22	0	3	1	0	0	2	2	0	28	4	44	40
INF.PACK.NO 23	1	3	1	0	1	1	3	0	41	5	51	50
INF.PACK.NO 24	1	3	2	0	1	3	1	1	49	6	51	60
INF.PACK.NO 25	1	3	2	0	1	3	1	1	49	6	51	60
INF.PACK.NO 26	0	1	0	0	0	0	0	1	3	1	19	10
INF.PACK.NO 27	0	1	0	0	0	0	0	1	3	1	19	10