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USE OF COMPUTERS IN STATISTICAL SERVICES IN AFRICA

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I. INTRODUCTION

1. At its eighth session, the Conference of African Statisticians expressed concern regarding the inadequacy of present data on computers used for statistics and called for better and more up-to-date information.

2. In view of this, in 1974, the secretariat of ECA organized a new electronic data processing enquiry in member States. The scope of the study was broader than that of earlier surveys and covered in particular existing or planned computers, statistical work which is being or is to be mechanized, data processers and training.

3. In March 1975, a year after the data was launched, the secretariat had received only 22 replies out of 41 countries. Out of these 22 replies, two countries stated that they did not have any computers and did not envisage acquiring any in the near future. There were therefore 20 questionnaires which could be used for the present document. However, when information has been available concerning countries which did not participate in the enquiry, it has been included in the document.

4. So that the information collected may reflect the situation in Africa as accurately as possible, it would be useful if the Conference of African Statisticians were to consider ways and means of improving future enquiries. Nevertheless, it may be thought that the results of this enquiry give a fairly meaningful picture of the way in which statistical services in the region use computers.

5. The following points will be discussed:

- Location of the computer in relation to the statistics-producing organ;
- Computer installations for processing statistical data;
- Mechanized statistical work;
- Personnel;
- Training.

II. LOCATION OF THE COMPUTER IN RELATION TO THE STATISTICS-PRODUCING ORGAN

6. Table 1 below summarizes the situation as regards the location of the computer in relation to statistics-producing organs.

7. The 34 countries for which the ECA secretariat has information concerning the place of computers may be classified into two groups.

8. The first group contains those countries where the statistical services do not have computers to process their work but can, with greater or lesser ease, use equipment in other departments. Nineteen countries are in this situation. For the most part, they have adopted a policy of centralizing processing facilities particularly as regards the public sector and have therefore established either national computer science offices, which are managed more or less independently, or national computer science departments, which are more integrated into the administrative machinery. In general, computer science offices and departments are attached to the Ministry of Finance which, by virtue of its management tasks, is initially the first client. But, as computer sciences develop, the applications

Table 1: Location of the computer in relation to the statistics-producing organ

Country	Computer available in the statistical service	Computer available in another service	Comments
North Africa			
Egypt	X		
Libyan Arab Republic	X		
Morocco	X		
Sudan		X	
Tunisia	X		
West Africa			
Dahomey		X	Direction du central mécanographique (Ministère des finances)
Ghana	X		
Guinea		X	Ministère des finances
Ivory Coast		X	Office central de la mécanographie (OCM)
Liberia	X		
Mali		X	Ministère des finances
Mauritania		X	
Niger	X		
Nigeria	X		
Senegal		X	Direction du traitement automatique de l'information (DTAI)
Sierra Leone	X		
Togo	X		Traditional equipment; installation of computer planned for September 1975
Upper Volta		X	Centre national du traitement de l'information (CENATRIN)
Central Africa			
Cameroon		X	Service central informatique
Central African Republic		X	Office national d'informatique (ONI)
Chad		X	
Congo		X	Office conglais de l'informatique (OCI)
Gabon		X	Direction de l'informatique (Ministère des finances)
Zaire	X		

Table 1: Location of the computer in relation to the statistics-producing organ (Cont'd)

Country	Computer available in the statistical service	Computer available in another service	Comments
East Africa			
Botswana		X	
Ethiopia	X		
Kenya		X	
Lesotho		X	Installation planned for 1975
Madagascar	X		
Malawi	X		
Mauritius		X	
Uganda		X	
United Republic of Tanzania		X	
Zambia	X		

are also directed towards the management of services other than financial ones. Thus, to meet the needs of all users, the central computers science service of Cameroon is attached to the office of the President of the Republic.

9. The second group includes countries where the statistical services have their own equipment which, for the most part, is used to process purely statistical work. The equipment can also be used to process the salaries of civil servants in Ghana but using only about one third of machine time. In Malawi, the statistical office has a UNIVAC 1004 computer and also access to the computers of the Malawi Railways Ltd. and the Portland Cement Company Ltd. In Zaire, there is another service involved with processing statistical work although the Institut national de la statistique already on its own uses an IBM 1401 computer; the other is the computer service of Zaire which operates within the office of the President of the Republic. This service, as well as serving to co-ordinate the computer policy of the country, has also established a data bank containing files on foreign trade, enterprises and workers.

10. In some cases, the computers operated by the statistical services are used by all the services within the administration. Then they are used to process such figures as the salaries of State employees, customs liquidations, tax rates, and so on as purely statistical work. The countries in this group are in particular Tunisia, Niger, Togo, Madagascar and Zambia. Togo has traditional equipment but there is some talk of replacing it by a third generation computer.

11. The problems which may arise from how the computers used to process statistics are located may be viewed in the light of the two groups mentioned above.

12. In the case of the first group, mention should be made of the difficulties which may arise when the statistical services and the computer services come under different ministries. In fact, statistical work may not be given priority in the ministry responsible for the computer service and might be processed only when the machine is available. The situation might become even worse when a very heavy load of statistics such as the processing of censuses has to be dealt with from time to time.

13. It might be appropriate to reserve a sufficient number of machine-hours per week for processing periodic statistics and to seek more appropriate solutions for occasional work with the offices in charge of computer sciences. Furthermore, it would seem necessary for statisticians to be trained to be computer correspondents. They would be responsible for ensuring liaison between the statistical service and the computer service. They would promote a dialogue between the statistician and the computer scientist. This suggestion remains valid wherever the computer is located in relation to statistics-producing organ, but it is even more justified in the present case.

14. With regard to the second group, i.e. those countries where the computers used to process statistics are located within the statistical services, mention may be made of the problem of overloading when there is an occasional heavy load. In fact, the computers used by this group are usually low capacity ones.

15. The solutions to this problem vary from country to country. Those countries which have adequate resources do not fail to provide their statistical services with computers of a relatively large capacity for major operations. Such is the case in the Libyan Arab Republic where the Department of the Census and Statistics has just acquired an IBM 370/135 computer with a memory size of 145 K instead of the old ICL 1902 computer with a memory of 48 K. Tunisia has also announced its intention of replacing the IBM 360/30 computer with a memory of 64 K used by the national statistical institute during this year by an IBM 370/125 computer with a memory of 128 K. Morocco also intends to change its equipment.

16. Another solution might be to use the computers available in other departments which are sometimes underused when there is major occasional work. This however means that the different pieces of equipment have to be compatible so that the operation may be followed through irrespective of the centre to which the work is entrusted.

17. Lastly, mention should be made of the ways in which the layout of the equipment may be improved in order to overcome the difficulties which may arise as a result of overloading. For example, the memory size of the computer, the data recording system and the way results are issued can be strengthened.

18. It should be noted that to a greater or lesser extent all the above mentioned problems may arise wherever the computer is located. The choice of solution will finally depend on the nature and volume of the work to be processed as well as the resources available.

III. COMPUTER INSTALLATIONS FOR PROCESSING STATISTICAL DATA

19. The main characteristics of computers used to process statistical data are given in tables 1 to 5 annexed hereto. In this chapter a brief review will be made of installations as far as data input, the processor, results and software are concerned.

1. Data input (see table 2)

20. As far as data input is concerned, it would appear that the procedure for verifying punch cards is not applied systematically. There are, for example, 17 verifiers for 19 punchers in the computer service of INSRE in Madagascar against only one verifier for 12 punchers in the computer centre of the Central Statistical Bureau in Zambia. It would appear that the Central Statistical Bureau of Ethiopia has no punch cards verifiers. In addition, some statistical services have their own equipment for punching and verifying cards although the computers are located within other services. This is the case in Sudan, Senegal, Lesothc and the United Republic of Tanzania. This practice means that bottlenecks can be avoided at the data input stage.

21. Most of the countries under review use 80-character cards. Zambia, on the other hand uses the 128-character cards.

22. As far automatic data input is concerned, not much equipment is available in the different computer centres. Out of the 20 countries which participated in the enquiry, only three - Morocco, Cameroon and Mauritania, use an optical reader. It seems that Algeria also uses this method. It would be helpful tc know the experiences of these countries because the method is practical particularly when the card preparation speed is slow. But these techniques require long planning and decisions concerning their use for statistical work such as censuses and surveys have to be taken when the content and presentation of questionnaires is being considered. Two countries, the Libyan Arab Republic and Morocco, use perforated strip punchers and verifiers. On the other hand, recording directly on disks or tape is more current because 8 countries use these methods or intend to use it. They are Morocco, Tunisia, Mauritania, Camercon, Botswana, Ethiopia, Lesotho and Zambia.

2. Processing (see table 1 annexed hereto)

23. Most of the computers now used to process statistics were installed during the 1970s to replace the computers with a lower performance acquired during the 1960s. This shows that to some extent African countries want to keep up-to-date with computer sciences. Two countries, Morocco and Tunisia, intend this year to replace the computers they installed in 1970.

24. With regard tc the type of computers used, the first place is held by IBM (serie 360), followed by ICL, Honeywell Bull, CII (IRIS) and UNIVAC.

25. It is interesting to note that in some countries the central storage capacity is fairly large (256 K and even 512 K). These are however primarily computer centres which process the work of all the services in the administration and are independent of the statistical services (United Republic of Cameroon, Senegal,

Ivory Coast, etc). Nevertheless, some statistical services have computers with relatively large central storage capacity. This is the case in Zambia (212 K) and in the Libyan Arab Republic (145 K).

26. At times the volume of work to be processed and the programming system used justify relatively large storage capacities. But mention should also be made of the fact that tests are frequently made because of the lack of experience of the specialized personnel in Africa, work is often done over again and organization is lacking. Despite these defects which should disappear as African countries come to conquer information sciences it may be said that such storage capacities will in the long run allow for effective multi-programming and produce a better yield from the computer.

27. Table 3 annexed hereto contains information concerning data support, particularly as concerns tape and band operators. It will be noted that most of the countries use cards, tapes and disks together. Two countries, Dahomey and the United Republic of Tanzania, use only cards and tapes and one country, Niger, uses only cards.

3. Output (see table 4 annexed hereto)

28. At this level, 13 out of the 20 countries have card operators. Among these, three, the Libyan Arab Republic, Morocco and Ethiopia, also have tape perforators.

29. The speeds of the printers installed in the various computer centres vary from 300-1,600 lines per minute. On the whole it will be noticed that the speed of the printer bears some relationship to the size of the computer. There are, however, exceptions such as Botswana where the 128 K computer is connected to a printer of 300 lines per minute whereas in Dahomey the 20 K computer is connected to a printer of 600 lines per minute.

30. It will also be noted that the printers used in certain North African countries such as the Libyan Arab Republic produce results in Arabic script.

4. Software (see table 5 annexed hereto)

31. Cobol and Fortran seem the most suitable for statistical work because the majority of the countries have said that they use the relative compilation manuals to translate programmes into machine language. Manuals for other languages include the PL1 and PL4, GAP and Algol compilers. In addition, some countries have or intend to have recourse to CENTS and COCENTS to process the population and housing censuses.

IV. MECHANIZED STATISTICAL WORK

32. In this chapter, a review will be made of the various statistics being mechanized or which are to be mechanized as well as the machine time devoted to current statistics.

1. Current or planned statistical work

33. Here a distinction should be made between periodic statistics and those which arise only from time to time.

34. Among the periodic statistics which are already mechanized foreign trade statistics take pride of place (see table 6). These statistics will become even more important when the New International Economic Order is established. However, mention should be made of the defects which are registered in this field both as regards the quality of data and the publication of results, which is often very late. It may be hoped that as computers are mastered by African countries, the defects will be overcome in due course. Then it will be possible to undertake more thorough studies at the regional level on trade among African countries and trade between African countries and the outside world.

35. Mention may also be made in this catagory of periodic work of the calculation of indices (retail price, wholesale price, foreign trade, production etc.), the number of vehicles, the establishments file, civil status, external migrations statistics, education and health statistics, etc. Such statistics are already being processed by computer in some African countries and other countries intend to do so. Another area which seems to be of concern to the countries in question is the mechanization of national accounting. This is already being done as an experiment in one country, Ghana, and five others, Morocco, Dahomey, Cameroon, Central African Republic and Lesotho, have already included a relevant project in their programme of activities.

36. Below is a list, albeit not an exhaustive one, of periodic statistics which are mechanized at the present time in only two or three countries at the most:

- Market prices
- Family planning
- Technical assistance
- Cadre training
- Tax statistics
- Civil aviation
- Village file
- National identity file of physical and moral persons
- Budgetary statistics
- Tourism
- Meteorological, hydrological, geological and other statistics
- Regression and correlation calculations
- Fortran calculations
- National centre for documentation

37. The major concerns as regards occasional statistics relate to the processing of population, agricultural and industrial censuses (see table 7).

38. Population and housing censuses are the most important. Out of the 20 countries in question, four now process their own censuses by computer and 14 others intend to do so within the next two or three years. It should be noted that the years 1975 to 1977 mark the end of the 1970 population census round and the beginning of the 1980 round, which explains the importance attached to processing census data at this time.

39. Two countries have included the processing of agricultural censuses among on-going work and three countries intend to carry out such tasks in the future. The figures are more or less the same for the processing of the industrial censuses.

40. Another occasional task is the processing of various statistical surveys (budget and household consumption surveys, demographic surveys, employment, and agriculture). Some of these surveys already represent a continuing task in some countries and may be classified among periodic work. This tendency will become more apparent in the future with the launching of the multipurpose African Household Survey Programme which is designed to establish permanent machinery for the collection of household data in different countries. The project falls within the framework of the implementation of the International Strategy and Africa's Strategy for the Second United Nations Development Decade which emphasize the need to improve the well-being of the population.

41. Some occasional statistical tasks such as road surveys, sociological surveys, literacy etc., are also mechanized in a few countries but not very frequently for the time being.

2. Machine time devoted to statistics

42. The machine time devoted to statistics depends on two main factors:

- The location of the computer in relation to the statistics-producing organ;
- The processing of voluminous but occasional statistics such as censuses.

43. Mention has already been made of the problems which may arise from the fact that statistical services use computers located in other services in the Administration. Table 2 below gives the machine time available to process statistical work in countries where the statistical services do not have their own equipment:

Table 2: Machine time for the processing of statistics by computers in other services

Country	Machine hours per week	Country	Machine hours per week
Dahomey	3 3/4	Chad	4
Mauritania	5	Botswana	4
Central African Republic	5	Senegal	3
		Sudan	31

44. It will be noted that the machine time devoted to statistics in the first six countries mentioned is no more than one-tenth of the total time the computer is used on the assumption that the computer is used 200 hours per month or 50 hours per week. On the other hand, the figure for Sudan is fairly high because of the fact that the population census carried out in the country in 1973 is being processed.

45. Table 3 below gives the same information for countries where statistical services have computers. Such information is available only for countries which replied to the specific question on the machine time.

Table 3: Machine time for processing statistical works when computers are available within statistical offices

Country	Machine hours per week	Country	Machine hours per week
Morocco	50	United Republic of Tanzania	24
Ghana	62	Zambia	15 to 20
Ethiopia	39	Madagascar	8

46. It will be noted that the time available for the computer to process statistical work is on the whole much higher than in the former case.

47. In particular, the figures for Morocco and Ghana can be explained by the fact that these two countries undertook to process their population censuses.

V. PERSONNEL

48. The data collected on computer personnel assigned to process statistics are fairly varied partly because the questions asked were interpreted in a variety of ways and partly because of the differences from country to country in the definition of the functions of computer personnel. This means that for some countries the figures provided are too low or too high.

49. Nevertheless, an attempt will be made to draw some conclusions from the available information.

50. It can be seen from table 8 and 9 annexed hereto that at the systems and programming levels there are 27 operators who are trained and experienced or who are being trained for the 19 countries which replied to the questions concerning personnel. It should be noted that four countries, Upper Volta, Dahomey, Madagascar and Zambia, according to the figures which were provided, account for about 85 per cent of the trained personnel in this category. They are probably all the staff used to process all administrative work.

51. There are also 35 systems specialists who are trained and experienced or being trained, of whom 77 per cent are to be found in Upper Volta, Zambia and Dahomey.

52. As far as actual programming is concerned, the countries in question as a whole have 96 qualified programmers of whom 56, or more than half, are classified as senior programmers and 36 others as programmers who are trained or are being trained and of whom 12 are senior programmers. Plans are being made to recruit 27 short-term staff in this catagory and 11 long-term staff.

53. As far as processing is concerned, there are 11 processors (chief processors, section chiefs, etc.), 23 specialists (chief operators, assembly chiefs), 32 operators and 52 assistant operators.

54. As far as off-line operations and administration are concerned, in all the countries there are three subject specialists DP liaison, 37 control staff (DP output clerical staff), 50 coding and 36 other junior staff. All the staff mentioned at this level are experienced.

55. At the level of data preparation, there are 40 supervisors, of whom 2 are under training and 352 punchers and verifiers of whom 16 are being trained. The recruitment estimates in this last category are low because they cover only three units.

56. Lastly, as far as output operations are concerned, only Zambia and Ethiopia have provided information relating in total to two senior officials and nine trained staff.

57. Table 4 below summarizes the current and future situation as regards the computer staff used to process statistics.

Table 4: Number of trained staff by category and recruitment estimates

Category of staff	Trained and experienced staff or staff under training (A)	Recruitment estimates (B)	Ratio in B/A
1. Systems, programming			
- Systems programming managers	27	1	3.7
- Systems specialists	35	15	42.8
- Senior programmers	68	19	27.9
- Junior programmers	56	19	33.9
- Programming assistants	10	-	-
2. Computer operations			
- Chief processors	11	1	9.1
- Assembly chiefs	23	3	13.0
- Operators	32	1	3.1
- Assistant operators	52	5	9.6
3. Off-line operations, administration			
- Subject specialists DP liaison	3	6	200.0
- Supervisory staff	37	7	18.9
- Coding staff	50	8	16.0
- Other junior staff	36	-	-

Table 4: Number of trained staff by category and recruitment estimates (Cont'd)

Category of staff	Trained and experienced staff or staff under training (A)	Recruitment estimates (B)	Ratio in B/A
4. Data preparation			
- Supervisors	40	6	15.0
- Puncher and verifier	352	3	0.8
5. Output preparation			
- Managers/specialists	2	1	50.0
- Other staff	9	-	-

58. It can be seen from table 4 above that there is a fairly high demand for specialists in processing statistics at the systems and programming level as well as at the level of off-line operations. The situation seems fairly satisfactory as far as processing and the data preparation staff are concerned. Generally speaking, the junior posts of punchers, checkers, programming assistants and assistant operators are filled since there are training facilities in all the countries under review.

VI. TRAINING

59. In the enquiry, computer staff were classified in the following five functional groups:

- System and programming staff;
- Computer operations staff;
- Off-line operations staff;
- Data preparation staff;
- Output preparation staff.

60. Before turning to training itself and the fields and sources of training, a brief review will be made of the tasks entrusted to each category of personnel.

1. Review of tasks

61. Systems analysis and programming staff are entrusted with studies, research and programming. Inter alia, their tasks include:

- Studies on the desirability of applications;
- Preparation of projects to be undertaken;
- Establishment of files containing functional analyses of projects;
- Establishment of files containing organic analyses of the process or part of the process;
- Design of the detailed organigramme of a programme;
- Adaptation of applications to operation systems of information centres.

62. Within this category, precise functions are assigned to the various specialists such as the director of studies, analysts, systems engineers, systems programmers, applications programmers, etc. This category of personnel should have a high standard of technical training and, depending on the individual speciality, a thorough knowlege of equipment, processing systems, analysis methods and programming languages.

63. Processing personnel are responsible for all the work performed by the computer. In addition to those officials who should receive advanced technical training, it is necessary for the staff to have a good knowledge of computer science as a whole: interpretation of the signals on the luminous dials and on the print-out machine, control of the proper operation of tapes, discs, readers, card punchers, printers, etc.

64. The tasks of the coding staff consist above all of controlling the receipt and quality of the documents to be processed and coding them. The liaison specialists should have a knowledge of systems analyses and programming if they are to perform their work properly.

65. The basic function of data preparation staff is to see to it that all the punching and the verifying work is done. Staff in this category should have a good knowledge of the layout of characters on a key-board and of the various operations relating to the running and manipulation of punching and verfying machines.

66. Lastly, as regards output preparation, the main tasks to be performed are to prepare tabulated reports, separate, cut and bend papers and in short to ensure that the documents prepared from the processed data are put into the proper shape to be sent to users.

67. Apart from the officials at the various levels and the systems and programming personnel who should have advanced technical training, other staff can usually be trained locally without any difficulty, generally with the help of computer firms.

2. Training sources

68. In view of the foregoing, attention will be focused primarily on the training areas for systems and programming personnel.

Table 5: Number of staff trained by area of study and training sources

Training organs	A	B	C	D1	D2	D3	E1	E2	E3
1. Systems									
1.1. Introductory	10	16	3	1	4	5	3	-	-
1.2. Basic systems	9	27	3	2	14	5	2	-	3
1 1.3. Advanced systems	5	5	-	-	-	-	-	-	3
2. Programming									
2.1. Assembly language	8	36	-	-	5	4	1	18	-
2.2. COBOL	39	92	39	10	20	5	30	17	4
2.3. FORTRAN	7	20	-	2	7	7	9	-	-
2.4. RPG	23	32	25	10	1	7	8	1	4
2.5. Other high-level languages	7	17	2	3	-	1	15	-	-
2.6. Statistical packages	10	23	13	3	2	4	6	-	-
2.7. Operating system languages	-	1	-	-	-	-	-	1	-
Total	118	269	85	31	53	38	74	37	14

A. Numbers trained and experienced.

B. Numbers already trained or in training.

C. Training within statistical office or within Government.

D. Training at United Nations or other non-commercial centres.

D1. Within country;

D2. Outside country, but within Africa;

D3. Outside Africa;

E. Training at manufacturers' or other commercial centres.

E1. Within country;

E2. Outside country, but within Africa;

E3. Outside Africa.

69. As far as systems are concerned, training areas may be divided into three headings:

- Introductory;
- Basic; and
- Advanced.

70. It can be seen from table 5 above that African systems staff are mainly trained in the first two areas. Relatively few are currently given advanced training.

71. It would be interesting to estimate to what extent systems personnel are trained in the three fields identified. On the basis of the figures contained in tables 4 and 5 above, it may be noted that the average number of fields of study per staff member is 1.2. In developed countries, the corresponding figure is at least 2.

72. As regards programming, the training areas identified relate primarily to languages:

- RPG;
- Assembly language;
- COBOL;
- FORTRAN; and
- Other high-level languages.

73. It should be noted in passing that systems personnel should also have a good knowledge of programming languages.

74. Again it can be seen from table 5 that COBOL, which is a high-level management language which can be used on all kinds of third generation computers, is the one most currently used for statistical applications.

75. Then come RPG, which is a simplified management language, assembly languages, FORTRAN, which is a high-level scientific language, and lastly the other high-level languages such as ALGOL and PL1.

76. Applying the method used for estimating systems, it emerges that each staff member (total system and programming staff) knows 1.6 languages on average. This figure is relatively low when one considers that the languages used should as far as possible be adapted to the various kinds of applications.

3. Training sources

77. Table 5 above shows that a large proportion of qualified computer personnel have been trained locally within statistical or administrative offices, in centres operated by manufacturers or in other non-commercial centres.

78. It should be noted that with the pressure of the rapid increase in the number of computers in Africa, countries in the region have been compelled to meet their immediate needs for computer personnel by organizing on-the-spot courses often with the aid of manufacturers. This training, generally of an accelerated nature, however, does not always enable the personnel to follow developments in computer techniques and to make the maximum use of the possibilities offered by the computer.

79. Training outside the country concerned but still within Africa also has a fairly important place. Information is given below on some of the centres which exist in the region to train computer personnel.

80. Lastly, training outside Africa, although coming in third place, is far from negligible. Apart from the figures given in table 5, the Libyan Arab Republic has made it known that it has established an intensive training programme for computer personnel. More than 150 students have been sent to the United States for training for three or four years in the various disciplines relating to data processing. The first graduates will be on the market at the end of 1975. Similar centres exist in France, the United Kingdom, Belgium, USSR, etc., and accept African students. It can however be said that the training offered in the developed countries in this highly specialized area often has the disadvantage of being too theoretical. It would therefore appear desirable to encourage the training of computer personnel in Africa in appropriate centres.

81. A number of such centres already exist. Among others, there are the Institut africain d'informatique (IAI) of Libreville, the Centre d'études et de recherche en informatique (CERI) at Algiers the Department of Computer Science at the University of Lagos and the Scientific Computation Centre at the University of Cairo.

82. The Institut africain d'informatique, which was established in 1971 by the States members of OCAM, provides short-term training for programmers and analysts-programmers who are able to use computer techniques, and also orientation courses for users. In the long-term, the Institute should inter alia train computer engineers and teachers and develop pure and applied research work. The training for programmers lasts for two years. During the first year, students receive basic instructions in computer sciences which ensures that they will have lasting competence and specialized instruction which will facilitate their entry into the profession. During the second year, they are given an on-the-job placement which ensures that they have a practical knowledge of actual problems. Analyst-programmers are trained in one year. Such training is offered to the graduate programmers of IAI and to programmers with adequate professional qualifications. Since it was opened in the month of October 1971, the Institute has trained some 136 students from 12 countries divided among four categories of programmers and analyst-programmers.

83. The ECA secretariat has little information on the other centres. It is, however, thought that the Algerian Centre d'études de recherche en informatique, which is recognized by the Intergovernmental Bureau for Information, an agency established under the auspices of UNESCO, as being international in character, provides training for computer personnel up to the level of engineer.

84. The Centre at the University of Lagos offers higher education in the form of a post-graduate diploma in computer sciences and in other fields relating to data processing.

85. It should lastly be noted that the United Nations Economic Commission for Africa actively participates in training data processing personnel. To this end, in 1973 and 1974, in co-operation with the United States Bureau of the Census and the Canadian Statistical Office, it organized two training courses concerning the tabulation of census data through the CENTS and COCENTS (application of the COBOL programming language to the CENTS method) systems.

VII. CONCLUSION

86. It has been noted that almost all African countries have computers to process statistics. The problems which have been raised both as concerns the location of the computer in relation to the statistics-producing organ and the specifications of the computers, which at times are no longer in line with the requirements of the new tasks to be handled, mean that solutions have to be adopted which are adapted to the conditions in each country. It should be stressed in this regard that at the level of each State a national computer science commission should be established with the responsibility of defining the national policy in this key field and co-ordinating the activities of the various services concerned. It would be helpful if, when the acquisition of a computer is being considered for example, account was taken of what is being done or what will be done within other services so as to ensure that the equipment used by the administration is as far as possible compatible.

87. Another important problem is the need for African personnel to master computer techniques. It should be recognized that Africa is still suffering from a lack of highly qualified computer personnel (design analysts, systems engineers, etc.). These functions are for the most part fulfilled by technical assistants and engineers from consultancy bureau. To some extent also manufactures make good for this shortage. There is also a shortage although less acute, of other categories of personnel, particularly programmers and analyst-programmers. But the problem here lies in the fact that the training offered to such agents is not always appropriate. The national computer commissions referred to above should therefore as a matter of urgency devise a national training plan for computer personnel.

88. Before concluding, it should be stressed that, in view of the growing interest in computers in the world in general and in Africa in particular, there is need for a periodical inventory of equipment and personnel in the field of computer sciences as they relate to the processing of statistics. In future enquiries, emphasis should be placed on obtaining data and more precise information on personnel as well as on the training possibilities offered in Africa. This can only be achieved through a joint effort on the part of the countries concerned and the secretariat.

ANNEXES

Table 1: Computers used to process statistics in Africa

Country	Computers used to process statistics	Storage capacity	Date of acquisition	Other computers in the administration
NORTH AFRICA				
Egypt	ICL 1904	32 K	...	...
Libyan Arab Republic	IBM 370/135	145 K	...	...
Morocco	IBM 360/25	48 K	1970	...
Sudan	IBM 360/30	32 K	...	IBM 360/20
Tunisia	IBM 360/30	64 K	1970	...
	IBM 370/125 1/	128 K	1975	...
WEST AFRICA				
Dahomey	HB GAMMA 30	20 K	1971	-
Ghana	IBM 360/30	64 K	1970	...
Guinea	IBM 1401	...	...	IBM 370/145, HB-2-H
Ivory Coast	IBM 370/145	...	...	2040, CII-2-IRIS 45
Liberia	IBM 360/20	8 K	...	...
Mali	HB GAMMA 10	...	...	HB GAMMA 10
Mauritania	IBM 3	32 K	1974	-
Niger	HB GAMMA 10	4 K	1967	-
Nigeria	IBM 360/25	24 K		
Senegal	IBM 360/40	256 K	...	IBM 360/40
	IBM 370/145 1/	...	...	IBM 370/145
Togo	IBM 370/115 2/	96 K	1975	-
Upper Volta	IBM 360/25	32 K	1973	-
	IBM 370/125 1/	...	1975	
CENTRAL AFRICA				
Burundi	IBM 3	...	...	-
Cameroon	IBM 360/40	256 K	1967	IBM 370/155
	IBM 370/155	512 K	1973	
Central African Republic	CII IRIS 45	80 K	1973	IBM 1401
Chad	IBM 360/22	32 K	...	-
Congo	IBM 370/125	...	1974	IBM 370/115
Gabon	CII IRIS 50	...	...	-
Zaire	IBM 1401	...	...	IBM-2-370/155
EAST AFRICA				
Botswana	...	128 K	1974	...
Ethiopia	IBM 3	48 K	...	...
Kenya	ICL 1902	...	...	...
Lesotho	ICL 2903	32 K	1975	...
Madagascar	IBM 360/40	64 K	1970	...
Malawi	UNIVAC/1004	...	...	...
Uganda	IBM 360/30	...	...	...
United Republic of Tanzania	ICL 1901 and 1902	64 K	1967	...
Zambia	IBM 3745	212 K	1973	...

1/ Replacement of existing computer planned.

2/ Installation planned for 1975.

Table 2: Input

Country	Optical character reader	Document reader	No. of card punchers	No. of card punch verifiers	PT punchers and verifiers	Key-to disc/ MT	Card type (No. of characters)
NORTH AFRICA							
Libyan Arab Republic	-[1]	-[1]	18	4	23[1]	-[3]	80
Morocco	x[1]	x[1]	x	x	x[1]	x[3]	...
Sudan	-	x	10+24[2]	9+8[2]	-	-	...
Tunisia	-	1-3881	10	7	-	1-3747	...
WEST AFRICA							
Dahomey	-	-	10	8	-	-	80
Ghana	-	-	x	x	-	-	...
Mauritania	x	-	x	x	-	x	80
Niger	-	-	5	4	-	-	80
Senegal	-	-	2	1	-	-	80
Upper Volta	-	-	6	4	-	-	80
CENTRAL AFRICA							
Cameroon	x[3]	-	x[3]	x[3]	-	x	80
Central African Republic	-	-	x	x	-	-	80
Chad	-	-	x	x	-	-	80
EAST AFRICA							
Botswana	-	-	8	6	-	4	80
Ethiopia	-	-	5	-	-	1	96
Lesotho	-	-	2+4[3]	1+2[3]	-	2[1]	80
Madagascar	-	-	19	17	-	-	80
United Republic of Tanzania	-	-	9	6	-	-	80
Zambia	-	1-3881	12	1	-	30	128

1/ Equipment belonging to or rented by other services.

2/ Equipment belonging to or rented by statistical office and other equipment used by that service.

3/ To be acquired by the statistical office.

Table 4: Output

Country	Computer output card punch	Computer output PT punch	Line printers - No.	Printers speed (lines/ minute)	Other output devices
NORTH AFRICA					
Libyan Arab Republic	1	1	X	1200	-
Morocco	X	X	1-1403	600/1100	-
Sudan	1	-	1	...	bandes, disques
Tunisia	1-2540/ 2560	-	1	1100/1200	-
WEST AFRICA					
Dahomeyf	-	-	1	600	-
Ghana	1-2540	-	1-1403	1000	1 052 Printer keyboard
Mauritania	4-129	-	1	600	-
Niger	1	-	1	300	-
Senegal	2	-	4-1403	1100	-
Upper Volta	1	-	1	...	-
CENTRAL AFRICA					
Cameroon	X	-	2	1600	-
Central African Republic	-	-	1	1000	-
Chad	X	-	1	600	-
EAST AFRICA					
Botswana	-	-	1	300	3 visual display units
Ethiopia	1 1/	1 2/	1	300	Bandes
Lesotho	-	-	1	600	-
Madagascar	-	-	2	1200	-
United Republic of Tanzania	-	-	2	600	-
Zambia	1-2540	-	2-1403	1100	1-1 627

1/ Punch speed : 60 cards per minute.

2/ Punch speed : 50 cards per minute.

Table 5: Software

Country	COBOL compiler	Other language compilers	Operating system
NORTH AFRICA			
Morocco	X	FORTRAN IV PL4, Assembly	DOS
Sudan	X	FORTRAN IV, GAP, Assembly, PL1	DOS
Tunisia	X	FORTRAN	DOS
WEST AFRICA			
Dahomey	X	FORTRAN	...
Ghana	-	GAP, Assembly, FORTRAN	DOS
Upper Volta	X	FORTRAN	DOS
Mauritania	X	-	DOS
Senegal	X	FORTRAN, PL4, Assembly	...
CENTRAL AFRICA			
Cameroon	X	FORTRAN, PL1, Assembly	Release 21.7
Central African Republic	X	FORTRAN	SIRIS 2
Chad	X	Assembly, GAP	DOS - Release 25
EAST AFRICA			
Botswana	-	COBOL PLAN, FORTRAN IV	Exec.
Ethiopia	-	GAP, FORTRAN	...
Lesotho	-	GAP II, FORTRAN	Exec.
Madagascar	X	FORTRAN, GAP, COCENTS	DOS
Tanzania	-	ALGOL, FORTRAN, EMA, FILAN	...
Zambia	-	GAP II, FORTRAN, Assembly	DOS/VS

Table 6: Pe

Country
NORTH AFRICA
Libyan Arab
Morocco
Sudan
Tunisia
WEST AFRICA
Dahomey
Ghana
Upper Volta
Mauritania
Niger
Senegal
CENTRAL AFRIC
Cameroon
Central Afr
EAST AFRICA
Botswana
Ethiopia
Lesotho
Madagascar
Malawi
United Repu
Zambia

* Mechaniz
X Already.

odic statistics already mechanized or whose mechanization is planned

	Foreign trade	Calculation of indexes	Vehicle fleet	Establishment file	Civil status	Migration statistics	School statistics	Medical statistics	National accounts	Labour statistics
Republic	X	-	-	-	X	-	-	-	-	*
	-	X	X	X	-	-	-	X	*	-
	X	-	-	-	*	-	-	-	-	-
	X	X	X	X	-	-	-	-	-	-
	X	*	*	*	-	-	-	-	*	-
	X	-	X	-	X	-	X	X	X	X
	X	-	X	-	-	-	-	-	-	X
	X	-	-	X	-	-	-	-	-	X
	X	-	-	-	-	-	X	-	-	-
	-	-	-	-	-	-	-	-	-	-
	X	X	X	X	-	-	-	-	*	-
ca n Republic	X	-	X	-	-	-	-	-	*	-
	X	X	-	-	-	-	X	X	-	-
	-	-	-	-	-	X	X	-	-	-
	-	-	*	-	-	-	-	*	*	-
	X	-	-	X	X	-	-	-	-	-
	X	-	-	-	-	X	-	-	-	X
lic of Tanzania	-	-	-	-	-	X	-	-	-	X
	X	*	-	-	-	X	X	X	-	-

tion planned.

Table 7: Occasional statistics already mechanized or whose mechanization is planned

Country	Population Census	Agriculture Census	Industrial and trade census	Consumer budget survey	Demographic survey	Agriculture including lifestock survey	Industrial survey
NORTH AFRICA							
Libyan Arab Republic	X	X	-	-	-	-	-
Morocco	X	*	-	X	*	X	-
Sudan	X	*	-	-	-	-	-
Tunisia	*	-	X	*	X	*	-
WEST AFRICA							
Dahomey	*	-	-	-	*	-	*
Ghana	X	-	-	X	-	-	-
Upper Volta	*	-	-	-	X	-	-
Mauritania	*	-	X	-	-	-	-
Niger	*	-	-	-	*	-	-
Senegal	*	-	-	*	X	-	*
CENTRAL AFRICA							
Cameroon	*	-	*	-	-	-	-
Central African Republic	*	-	-	-	-	-	-
EAST AFRICA							
Botswana	*	-	-	*	-	-	-
Ethiopia	*	-	-	*	X	-	-
Lesotho	*	-	-	-	X	-	-
Madagascar	*	-	-	-	-	*	-
Malawi	*	-	-	-	X	X	-
United Republic of Tanzania	-	X	*	*	X	-	-
Zambia	*	*	-	-	-	-	-

* Mechanization planned.
X Already mechanized.

Table 8: Personnel - Systems/programming, operations

Country	Systems/ programming managers		Systems specialists		Senior programmers		Junior programmers		Programming assistants		Operations managers		Operations chiefs		Operators		Assistant operators	
	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
NORTH AFRICA																		
Libyan Arab Republic	1	-	-	-	1	-	3	-	-	-	1	-	-	-	1	-	2	-
Morocco	-	1	-	2	17	5	-	-	-	-	-	-	9	3	-	-	-	-
Sudan	-	-	-	-	2	-	6	3	-	-	1	-	-	-	3	-	4	-
Tunisia	-	-	2	-	4	8	1	9	-	-	-	-	1	-	-	-	3	2
WEST AFRICA																		
Dahomey	4	-	4	-	2	-	-	-	-	-	1	-	2	-	2	-	7	-
Ghana	-	-	-	-	1	-	3	-	3	-	-	-	-	-	3	-	10	-
Upper Volta	11	-	15	3	-	-	-	-	-	-	2	-	1	-	-	-	2	2
Mauritania	X	-	-	7	-	1	-	-	3	-	1	-	3	-	-	-	-	-
Niger	-	-	-	-	-	-	3	-	3	-	-	-	-	-	-	-	4	-
CENTRAL AFRICA																		
Cameroon	-	-	-	-	2	3	2	4	-	-	-	-	-	-	-	-	-	-
Central African Republic	1	-	1	-	4	-	5	-	-	-	-	1	1	-	-	-	5	-
Chad	-	-	-	-	2	-	6	-	-	-	1	-	4	-	-	-	-	-
EAST AFRICA																		
Botswana	1	-	-	-	3	2	-	-	-	-	-	-	1	-	1	-	2	-
Ethiopia	-	-	-	1	1	-	1	3	-	-	1	-	1	-	-	1	2	1
Lesotho	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Madagascar	4	-	2	2	23	-	-	-	-	-	1	-	-	-	13	-	-	-
Malawi	1	-	-	-	-	-	6	-	1	-	1	-	-	-	3	-	4	-
United Rep. of Tanzania	-	-	2	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-
Zambia	4	-	8	-	6	-	16	-	-	-	1	-	-	-	6	-	7	-
Total	27	1	35	15	68	19	56	19	10	-	11	1	23	3	32	1	52	5

T : Trained and experienced or being trained.
P : Recruitment planned in the short- and long-term.

Table 9: Personnel - Off-line operations and administration, data preparation, output preparation

Country	Liaison specialists		Control staff		Coding staff		Other Junior staff		DP super-visors		Punchers and checkers		Output preparation managers/ especialists		Others	
	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P
NORTH AFRICA																
Libyan Arab Republic	-	-	2	-	2	-	-	-	1	-	60	-	-	-	-	-
Morocco	-	-	3	-	17	6	3	-	6	5	-	-	-	-	-	-
Sudan	-	-	-	-	-	-	-	-	10	-	50	-	-	-	-	-
WEST AFRICA																
Dahomey	-	-	-	-	1	-	6	-	-	-	-	-	-	-	-	-
Ghana	-	-	16	-	-	-	-	-	5	-	44	-	-	-	-	-
Upper Volta	1	-	-	-	10	-	-	-	-	1	1	-	-	-	-	-
Mauritania	-	1	-	4	-	2	-	-	4	-	9	-	-	-	-	-
Niger	-	-	1	-	-	-	-	-	-	-	10	-	-	-	-	-
CENTRAL AFRICA																
Cameroon	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-
Central African Republic	-	4	-	2	-	-	6	-	1	-	10	-	-	-	-	-
Chad	-	-	1	-	-	-	4	-	-	-	9	-	-	-	-	-
EAST AFRICA																
Botswana	-	-	-	-	-	-	-	-	1	-	10	-	-	-	-	-
Ethiopia	-	1	-	1	6	-	-	-	1	-	7	-	-	1	1	-
Lesotho	-	-	-	-	-	-	-	-	1	-	7	-	-	-	-	-
Madagascar	1	-	11	-	14	-	17	-	3	-	32	-	-	-	-	-
Malawi	-	-	-	-	-	-	-	-	1	-	15	-	-	-	-	-
United Republic of Tanzania	-	-	-	-	-	-	-	-	3	-	45	-	-	-	-	-
Zambia	1	-	3	-	-	-	-	-	3	-	43	-	2	-	8	-
Total	3	6	37	7	50	8	36	-	40	6	352	3	2	1	9	-

T : Trained and experienced or being trained.
P : Recruitment planned in the short- and long-term.
DP: Data preparation.
OP: Output preparation.

Table 10: Number of staff trained by field of study and training source

Country	Introductory	Basic systems	Advanced systems	Assembly language	COBOL	FORTRAN	GAP	Other high-level language	Statistical packages
NORTH AFRICA									
Libyan Arab Republic	2A, 2B	-	1B	-	4A	2A	1A		2A (CENTS)
Morocco	2A/E1	1A/E3	-	2A, 1B/E3	17A, 11B/C, E1	6A, 1B/E1	-	11A, 4B/E1(PL1)	1A, 1B/C, E1 (CENTS)
Sudan	1B/C, D1, E1	1A/C, D1, E1	-	-	8A/C, D1, D2, E1	1A/D2	4A, 3B/C, D1, D2, E1, E2	-	-
Tunisia	-	2A	2A	-	8A, 2B/3C, 5D2, 3E1, 2E3	1A/D2	-	-	-
WEST AFRICA									
Dahomey	-	13A, 3B/10D2, 3D3	-	-	-	-	-	-	-
Ghana	-	2B/2E3	2B/2E3	3A, 1B/2C, 2D1, 4D2, 2D3, 2E1, 2E3			7B/2C, 4D1, 4D3, 5E1, 4E3	-	-
Mauritania	1B	-	-	3A, 3B	3B/3D2	-	-	-	-
Niger	-	-	-	2A/1D2, 1E2	-	-	-	-	-
CENTRAL AFRICA									
Cameroon	-	-	-	1A/D3	2B/1D1, 1D3	3A/1D1, 2D3	4B/3D1, 1D3	3B/3D1	-
Central African Republic	4A/4D2	4A/4D2	-	4A/4D2	14A, 5B/3C, 4D2, 2E3	4A/4D2	-	-	-
Tchad	-	-	-	2B	6A, 6B	-	-	-	-
EAST AFRICA									
Ethiopia	2A/2D3	1A, 1B/1D1, 1E1	-	2A/2D3	2A, 1B/1D1, 2D3, 1E1	2A, 1B/1D1 2D3, 1E1	4A, 4B/2D1, 2D3, 2E1	-	4A/4C, 2D1 2D2 (CENTS + COCENTS)
Lesotho	-	2A/2D3	-	1A/1D3	2A/2D3	2A/2D3	-	1A/1D3 (BASIC)	2A/1D2, 1D3 (CENTS) 1A/1D3(FIND + FILETAB)
Madagascar	-	-	2A, 1B/1E3	17A/17E2	17A/17E2	-	17A/17C	-	2A/2D2 (CENTS)
Malawi	3A, 3B/3D3	-	-	1A/1C	5A/5E1	-	5A, 5B/5C	2A/2C	16A, 8B/8C, 3D3, 5E1 (CENTS)
United Republic of Tanzania	1A, 1B	1A, 1B	1A, 1B	1A, 1B	5A, 2B/2E1	2A, 2B/1D3, 1E1	1A	1A	-
Zambia	2A, 2B/2C	2A, 2B/2C	-	-	14A, 5B/14C	-	-	-	-

A: Number of trained and experienced staff.

B: Number of staff trained or in training

C: Training within the statistical office or the administration

D: Training in United Nations or other non-commercial centres

D1: Within the country

D2: Outside the country but within Africa

D3: Outside Africa

E: Training at manufacturers or other commercial centres

E1: Within the country

E2: Outside the country but within Africa

E3: Outside Africa.