Technical Report

DEVELOPING COUNTRIES AS A MARKET FOR SOFTWARE EXPORTS: THE VIEW FROM INDIA

By

J.G. Krishnayya

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Name of the Author J.G.Krishnayya

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ABSTRACT (within 250 words)
(as given on paper)

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Abstract

The developing countries constitute a significant growth market for computer systems and software. Analysing the needs of this market and the difficulties they present, we find that they require problem analysis, systems design, hardware and software integration, training and facilities management. India has some advantages as a base for meeting these needs. Competition with established firms will however require a distinctive strategy. The possible advantages of "not relying on IBM" are reviewed. Successful operations will require a commitment of personnel on site for short and long periods. This places a premium upon a good base in a growing home market as well as a sophisticated organization design involving a consortium of software houses.

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1. Developing Countries and Computers

The growing attention in United Nations circles to the role of computers as catalysts for development, the Secretary-General's Experts Panel Reports of 1971(A) and 1973(B) and the recent World Conference on Informatics in Government (C) all reflect a new reality: the computer use in developing countries is at a take-off point and in some countries is already moderately advanced.

Sophistication too is growing. In 1971, much of the discussion at the Jerusalem Conference on Information Technology(D) for developing countries concerned population registers and rather elementary data-accumulation systems. In contrast, a year later at the Florence Conference on Informatics in Government(C), the Cameroun republic reported on a tele-processing system for monitoring imports to ensure prompt collection of customs dues.

Figure 1 illustrates the growth in the number of computers in 7 countries over the 9 years from 1962-71. It is strikingly evident that irrespective of their state of development, these countries have had a very similar pattern of doubling their computer population every 3 to 4 years. (Oil rich Iran has grown faster, as did Israel in the early 1960s.)

We can expect then that this doubling period will hold true for other developing countries too. Keeping in view the fact that computer costs are declining while their capabilities are growing (and that they neither consume raw-materials nor produce polluting effluents), we can conclude that the amount of raw computer power available in and to developing countries is likely to continue growing at a rapid rate. This capability can be made use of to provide effective information services to speed development. The consequent demands upon system design capability are likely to far exceed available indigenous resources (see Table III). This bottleneck can only be beaten by (a) either using only standardised, packaged 'information systems' or (b) importing design skills. Prepackaged systems with a wide applicability are already provided by manufacturers. In fact

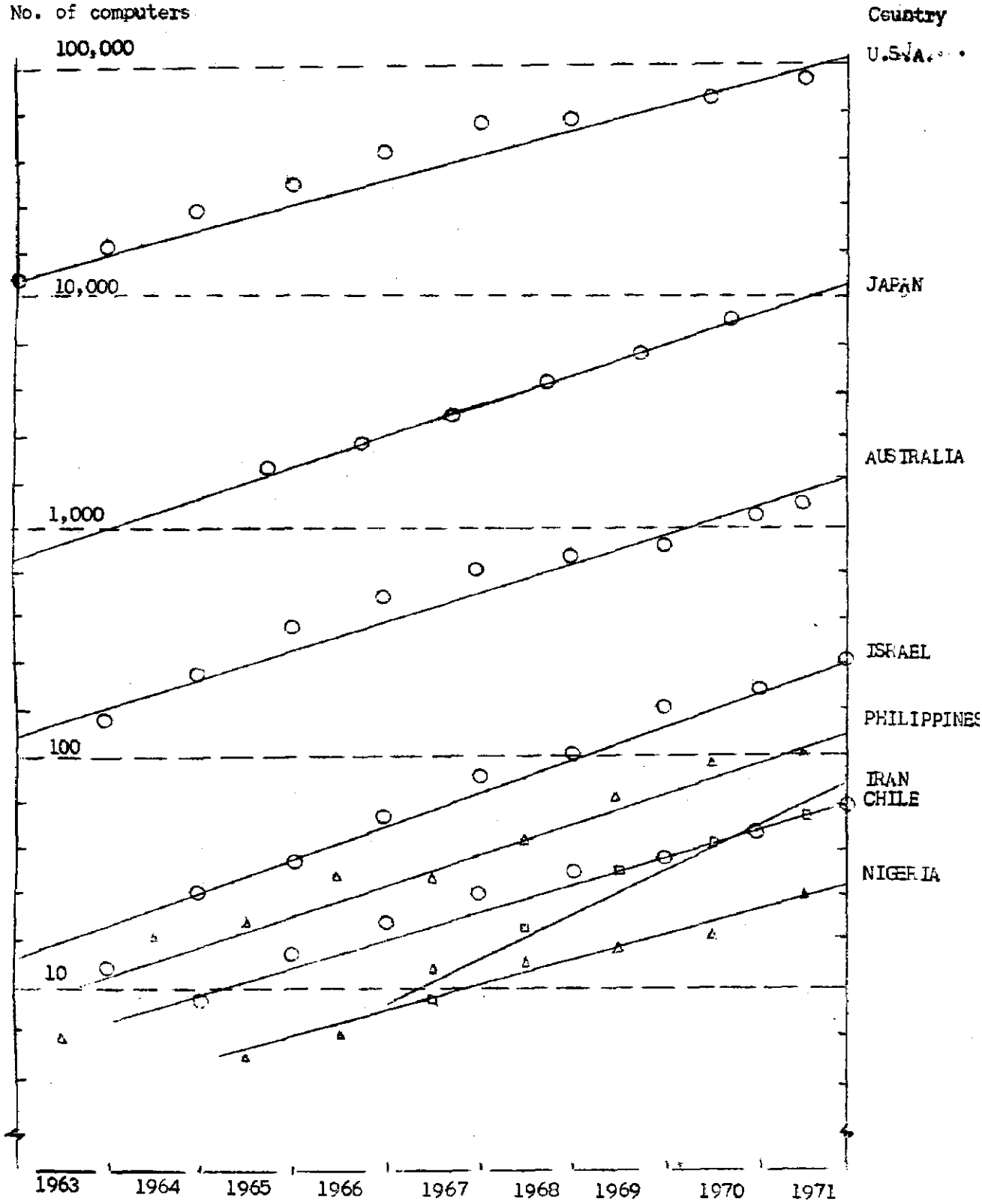

Fig. 1. Growth in Number of Computers 1963-71.
Source: (B) Annex I, Page 13

Table I. Selected UDC's: Computer Statistics by Number & Usage (1971)

Country	Total number	Education & training (5-10%)	Inventory distribution & manufacturing	Business administration	Public administration & statistics	Percent of Systems in Public Administration
Bolivia	6	1	3	1	2	33
Brazil	1,219	110	475	445	189	17
Central African Republic	3	-	-	-	3	100
Columbia	82	7	40	20	15	18
Cyprus	5	-	1	3	1	20
Fiji	6	-	-	2	4	66
Greece	175	7	38	75	55	32
Iraq	7	1	1	3	2	29
Jamaica	34	3	8	20	3	9
Kuwait	17	1	8	7	1	6
Lebanon	29	-	4	14	11	38
Madagascar	24	1	3	15	5	21
Malaysia	28	1	7	7	13	47
Morocco	52	3	-	29	20	39
Nicaragua	14	-	-	8	6	43
Singapore	34	3	5	18	8	24
Sudan	4	1	1	-	2	50
Thailand	27	4	6	2	15	55
Turkey	82	8	43	20	11	15
Upper Volta	1	-	-	-	1	100
Zaire	19	4	-	15	-	-

Source (B) Annex.1 Page 8.

Table II. Selected UDG's: Computer Statistics by Number & Size (1971)

Country (Value)	Total number	Mini/small (< $150K)	Medium (> $150K)	Large (> $500K)	Very large (> $1M)
Algeria	63	31	22	5	5
Bolivia	6	6	-	-	-
Brazil	1,219	981	193	21	24
Cameroun	10	7	3	3	-
Chile	57	na	na	na	na
Colombia	82	18	44	16	4
Ethiopia	9	8	1	-	-
India	183	177	5	1	-
Iraq	7	6	1	-	-
Iran	49	42	6	1	-
Kuwait	17	4	4	9	-
Lebanon	29	20	7	2	-
Medagascar	15	11	4	1	-
Malaysia	28	17	10	1	-
Philippines	120	na	na	na	na
Singapore	34	10	12	10	-
Sri Lanka	9	9	-	-	-
Sudan	4	4	-	-	-
Thailand	27	16	11	-	-
Tunisia	25	25	-	-	-
Turkey	82	71	7	4	-
United Arab Republic	27	na	na	na	na
United Republic of Tanzania	7	5	2	-	-
Zaire	19	11	7	1	-
Zambia	5	3	2	-	-
TOTALS FOR These Countries excluding Brazil and pro-rating Chile, P.I. & U.A.R.	916	644	191	70	11

Source (B) Annex 1 Page 9

it is likely these constitute the bulk of present usage. However these may not meet the critical needs of a developing country discussed in Section 1.4 below.

The Francophone countries of Africa like Cameroun have made visible progress in Informatics under the guidance of French experts. France has not stinted in efforts to maintain its role as the source of technical sophistication for that Community. At the Institute African d'Informatique, training courses are run for short and long periods, and a Community Commission on Informatics coordinates the work in these countries.

1.1 Manufacturer attitude

In comparison, English-speaking developing countries have not moved ahead so fast because a limited initiative has generally come only from manufacturers — I.B.M. and I.C.L. principally but also N.C.R. and Burroughs.

Manufacturers, as is well-known, must be primarily concerned with selling hardware and, to lesser extent, with loading it up with time-consuming jobs. Short-run business considerations have understandably led them to neglect or to ignore in developing countries the exhaustive and competitive customer education which takes place, naturally in developed countries, and which leads to better applications from the management point of view.

Tables I & II illustrate the distribution of computers by application and by size in some developing countries. These data appear to justify the feeling that most of the developing countries are qualitatively in the same situation with respect to computer applications though some have better access to hardware than others. If we exclude Brazil, we find seventy per cent of the installed systems are categorised as mini or small systems and 21% are medium i.e. small CPUs with discs or large CPUs with tape only. Under 8% are 'large' - i.e. big CPU with disc capability. Only Brazil, Colombia and Algeria have systems costing over $1M.

Tables I & II can be looked at in two ways - first to confirm that computer-power has indeed penetrated into UDCs on a very wide basis geographically and presumably has had some effect upon the thinking of potential users in those UDCs; and second to highlight the gap between the real potential today of computer technology (using random - access files, information retrieval, on-line data capture, etc.) and the expectation (leave alone usage) in UDCs - governed as these are by the capabilities of the relatively simple punched-card and tape systems they have seen. Taken together with Table III, which shows the numbers of profession EDP staff available, we see the real gap - the 'software' gap: the absence of shortage of system designers - which is aggravated by the pressure upon the few EDP professionals in UDCs to get some use out of their existing equipment, which reduces the time available for them to take stock of the new possibilities in their changing technology. Here and there we find individual (foreign) firms in advanced technology such as an oil company, power company, bank or airline who may acquire computer equipment. Individual U.N. agencies such as F.A.O., U.N.I.D.O., W.H.O., etc. may recommend single computer applications.

Experience reveals, however, that the strain of starting up and running such an island of high technology is very often beyond the host country organisation which is supposed to benefit from it. Nevertheless, such installations are rarely totally shut down even when their outputs and information are rejected by the concerned managers or decision makers. The usual outcome is a very low level of productivity for several years and increasingly on simple tasks until more demands arise for EDP services - by which time the original installation is probably obsolete anyway.

1.2 Receptivity in Government

In most developing countries Governments are and will be the major potential users of information technology. Until there are enough top government executives who know how to use information for decision making, computer capability is premature. On the other hand, once the top rungs are alert to the uses of information, it is the absence of an effective and accurate flow of information which handicaps them.

Table III*. Seven Countries: Computer Personnel Data

(Obtained from responses to the Secretary-General's questionnaire or background papers)

Country	Number of computers	Number of personnel	Managers	Systems analysts	Programmers	Operators	Administrative and maintenance crews	Punch card operators
Austria	699	1,027	49	44	138	143	167	493
Ethiopia	8	101	6	4	16	18	2	55
Israel	257	-	14%	22%	31%	33%	-	-
Japan	11,237	116,500	7,500	15,000	35,000	18,000		41,000
Kenya	17	324	17	24	88	45		
Malaysia	28	741	31	84	65	63	109	389
United Republic of Tanzania	6	170	6	10	38	19	5	92

* Source: (B) Annex 1, Page 19.

In the continued absence of effective information technology, however, even alert officials will fall back upon methods of decision-taking that place less reliance on the data they receive, and more on personal judgement. Therefore information system building should rapidly follow the recognition of their need.

Most developing countries exhibit a considerable rate of change in roles at the upper echelons of the government, as new functions are recognised, new projects undertaken or new departments and agencies created. In this fluid situation there will always be some who recognise the value of good information services and who will support the design and building of information systems, and others who still need to be shown. It is precisely here that the availability, on contract terms, of credible informatics and software skills, ready and willing to work in the UDC can make a major difference.

In many situations a mere reformatting of red-tape-bound file bundles into alphabetised and card-indexed data will constitute a dramatic improvement in information services. Unfortunately the know-how required to perceive, design, implement and maintain such measures may be even more scarce than the know-how that comes with a computerised information system whose very hardware machine-ness provides an asssurance that the procedures will be continued (unlike the ordinary Kardex system, so many of which are soon neglected by complacent clerks). It should be said also that a successful information system - manual or machine-based - is one which generates from its users ever more demands upon its capabilities. Therefore a good manual system would probably soon grow to computer size and would have had to be designed with that in mind to begin with.

We need to stress perhaps that there are three levels of involvement in an information system project in a UDC:

(a) The Users - the managers and decision makers who need define, commission and support the project.

(b) The people who have to run it, statisticians, accountants, bureaucrats, clerks: once the system is handed over to them, they have to operate it and keep it alive and on track.

(c) The designers and implementors. They need not all be part of the local scene though there are obvious advantages in a continuing presence of some kind. However, we must recognise that Design talent in reference to Information Systems is a very scarce resource, and cannot be produced or found in the same quantity as the skills require to run a system along set principles. Designing reliable, fail-soft information systems for the UDC environment is even more demanding of professional skill.

The critical factor is the receptivity of the User community, which in turn is a function of their felt needs and their perception of the benefits to be had from information technology. We believe this has been and is growing, and can be accelerated in relation to certain important sectors of the UDC economy and government.

1.3 At the interface with advanced societies

The present close coordination of many developing countries with aid giving and term-lending agencies like the U.N.D.P., I.M.F. and I.B.R.D., means that there is need, at the interface between the government of the developing country and the agency, for information formatting and translation from one context to another, conceptually in terms of source-and-uses of funds, administratively from projects to sectors and departments, and operationally in monitoring the flow of funds and material inputs and the corresponding output measures.

The parellel growth of a critical export-import trade sector and of capital investment in facilities like port and transportation infrastructure and in industrial equipment requiring carefully scheduled usage and maintenance, introduces all the usual time-critical management applications of information technology.

Good P.E.R.T. systems for instance, though seldom available, could be enormously helpful in respect of the management of all projects. Control and monitoring of foreign contractors and foreign enterprises equally require management information systems. These are all applications for information technology which are ready today for exploitation and do not depend upon the transition of a developing into a developed country.

1.4 Critical Sectors with a high multiplier effect

It is possible to examine more closely the information needs of developing countries and to uncover specific informatics applications which will have a strong catalytic effect on social development and economic growth.

1.4.1

The first is clearly at the external economic interface with the highly systematic and formetted decision and information systems of the already developed countries, their trade and financial institutions and their statistics-generating agencies.

Let us empnasise that this interface is not visualised as a one-way information transfucer which takes facts from a UDC and transforms them to formats compatible with developed country systems and procedures. (This data-translation is of course necessary, particularly for generating information related to effective utilisation of foreign grants and credits.) We would, on the other hand, draw attention to the need for a mechanism whereby relevant economic data about the developed countries, about international trade and finance, become available in a convenient way to the decision-makers in the UDCs. If the UDC leaders have ready access to this information, for example on commodity prices in world markets, it will be possible for the UDC to develop and to use more effectively its own export and import strategy and to improve its bargaining position in trade and aid discussions. It is impractical to provide this service with an information content that is uptodate except through a computer-based system designed on uptodate informatics principles and which draws upon 'published' computer-compatible data from developed countries.

It is precisely such a system property of being on top of the current (trade) situation - rather than struggling with a hundred volumes of printed and mimeographed statistics two or more years old - that can give the UDC officials added weight to counter-balance the information/analysis advantage that the advanced country delegation normally - almost inevitably - has in bilateral or multilateral discussions.

1.4.2

Another major area for computer-based information system in developing countries is monitoring the development and utilisation of capital assets - that is, at the interface with capital-intensive technology. Most UDC's depend for the success of their development strategy upon the installation of infrastructure investments, and manufacturing or processing plants. In the construction phase these are usually operations for which various expatriate agencies and contractors have partial responsibility. Often they are already equipped with information subsystems. A computer-based information system for the UDC government could integrate these project subsystems and ensure effective performance of the tasks/projects.

During the operational phase, too, infrastructural investments in power, transport, irrigation, etc. must be productive. If their performance is monitored by an information system that incorporates sensitive computer programs, it is possible not merely to detect early changes in efficiency but also to anticipate second-order and tertiary effects. In the case of manufacturing or processing concerns, a monitoring system is essential because of the multiplier effect of the value-added and taxes-paid by the plant. Not least, its efficiency in utilizing the flow of raw material through it is an important part of the UDC's development strategy.

1.4.3

The logistics of food, fuel, agricultural products and other moving inventories are another area where informatics work can offer a high pay off in every UDC. In most cases, the critical problems are not in the collation or analysis of such data, but earlier, in the accurate recording of the actual transaction. It is necessary to send back to the source a transcript of the computer's version of the transaction for error checking. This gets progressively more difficult as the source moves farther away from the computer. It is likely, therefore that centralised facilities, such as 'national' computer centres in UDCs will be useful for logistics *management only in geographically very compact nations.*

Elsewhere, some form of 'on-line' transaction recording will be necessary: either simulated, by voice contact over the telephone

or by telex message or in fact onto a 'local' computer which is a link in the information chain. The links in this network may be telephone circuits - or messengers carrying tape, diskettes, or cassettes. We believe that communications-oriented minicomputers can overcome some of the difficulties associated with the skeletal trunk-line communications facilities in UDCs, by providing active buffers for message switching and dynamic coding to overcome transmission difficulties. Because of the small "steps" of investment involved in 'growing' minicomputer-system capacity, and the increasing availability of peripherals for the socalled 'mini's, the pattern of the future for UDCs may well be distributed minicomputer networks for logistical applications, despite the generally primitive communications.

1.4.4

We have identified three sectors of government activity where informatics has a high economic multiplier. Another is, of course, the analysis of statistics and accounts at City, province and federal levels. Here the computer-based system will not only compile statistics but also analyse the forecast and assist in short and medium-term planning.

The critical difference in an 'informatics' approach to this statistical-analysis task is that it is not seen as an end in itself, but as an urgently needed tool for the policymaker, providing in an iterative manner uptodate and sufficiently well-indexed information ad hoc - as it is needed and called for. The ability to provide a view of 'alternative futures' through simple economic or complex simulation models is, of course, an essential component here.

1.5 Overcoming the difficulties of implementing Informatics systems in UDCs

These difficulties fall into three groups -

(a) Those related directly to the technology - the equipment and programming systems.

(b) Those related to commissioning the use of Informatics.

(c) Those related to operating and utilising the informatics systems once they are built.

None of these need be underestimated, but in each case the pay offs for overcoming them are so high that we can study the possibilities more closely.

1.5.1

Hardware maintenance is a most serious difficulty, in fact guaranteeing and providing maintenance lies on the critical path of any computer project in UDCs. The solutions lie in two directions: by utilising hardware for which local maintenance is provided by a manufacturer or by an OEM-type Systems house (perhaps the consultant informatics agency itself); or by adopting a systems design and hardware strategy which is not dependent on any one component and which provides for fail-soft or gradual degradation of performance, in case of equipment failures, during the time period required to diagnose the problem and fly in the necessary part. A combination of the two strategies is best, but redundancy might be a very expensive proposition when an entire system is procured from a major manufacturer such as IBM at normal prices. Fortunately, computer technology especially at the smaller end of the spectrum has been moving in a direction which makes redundancy (even in disc and tape units) less expensive than it was even three years ago.(E)

Executive software systems and compilers are another 'basic' requirement. Their reliability is harder to detect than that of hardware. Hidden bugs may surface after the system is in use. These can be insured against by a conservative selection among available CPU suppliers, perhaps passing up the most novel system in favour of one from a manufacturer with a good track record on his software.

1.5.2

The decision to commission work on Information Systems for UDC government is essentially a political one. It will be taken when government leaders are persuaded that their leverage over economic forces (internal and external) will increase markedly through the use of informatics, and when they perceive they can afford the political costs (however slight) involved not only in generating and formalising information about their country and its economic affairs

and relations, (and therefore revealing it domestically as well as abroad to some extent), but more particularly in doing so with the assistance of foreign expert and equipment.

Other hurdles, such as the feasibility of applying informatics in a given situation are not considered here, since there are so many situations awaiting attention where good design of a system will indeed bring sizeable benefits, that there would appear to be little need to push applications which are doubtful.

In many UDCs, including some which are otherwise sophisticated, the critical catalytic role of accurate uptodate information is not yet perceived. This perception cannot be brought about by conventional marketing and educational techniques or by lectures by visiting experts, or even by writings such as the present article.

Collating a number of case studies, we now hold the view that almost the only way in which this is learnt (not taught) is by repeated personal exposure to a working example of good informatics. Since many persons in the upper echelons of a UDC have the power to slow down the adoption of a new idea, it is consequently necessary for nearly all of them to have had such learning experiences. Initially these exposures could be sponsored by a special unit of the UN office of Science & Technology (see (E)), the IBI-ICC, the OECD etc. At the earliest possible stage such viewings should be held in UDCs and preferably in their own country. (This places a premium on the initial selection of an application which requires the minimum consensus in the UDC government.)

Meeting the political objections to informatics based on foreign hardware and software expertise is more difficult.

One possibility is for a multilateral government-owned international corporation to undertake hardware supply and support, in effect insulating a given country from the source of its hardware and operating software. This suggestion has not been taken very seriously, so far because the UN has not yet moved in a major way into informatics in UDCs. It may indeed not be necessary as long as there are checks and balances built into the relations between UDCs and the very large computer manufacturers.

In a similar way, the human system design skills and informatics expertise can be supplied from a multi-national source. However, such an agency may not have the flexibility and rapid response needed in this field. It is more likely that existing and new firms with software and information systems design expertise interested in the UDC market may instead internationalize their own staff and train local persons when on a job in a UDC. The possible advantage of India-based firms in this matter is a major point of this paper.

1.5.3

Getting the request from or clearance and support of the upper echelons is only the start of the difficulties. It is necessary, first that the systems design be made in full awareness of local conditions, and then that the operators and users of the system not only understand its strengths and weaknesses, but also the procedural demands it places on its data sources.

These are all basically educational problems and are solveable once they are recognised. The solutions may, however, be costly in terms of human time. In order to build into the information system design a strong awareness of local conditions (and, equally important, of their dynamics), an expert local collaborator is necessary. Training for expertise in Informatics is not yet available in English-speaking UDCs but some efforts (F) are being made in this direction. The French program in Libreville, Gabon, is a good example of a combined Computer Science and Informatics programme at University (undergraduate) level in sandwich form for civil servants and others. Training that takes place in developed countries is less satisfactory because of the differing priorities in curriculum and pedagogy imposed by their stage of development. Another means for developing expertise is for middle level professional workers Accountants, Engineers, Army Officers or Civil Servants - from UDCs to be attached to consulting firms for periods of 6 months to a year. They have already a good acquaintance with the administrative, economic, technical and educational environment in their country and need to absorb the facts about computers & computerised systems and to fit them into the matrix of their own working environment.

As distinct from local expertise during the design process, the need for developing operator and user expertise is much less urgent. In fact this can be effectively built up during the time the system is being formulated, built and tested. Advanced educational technology such as films, VTRs, etc. have genuine value here as having greater communicative power while conveying also a necessary element of prestige (or snob appeal) to the new system being thus introduced.

2. India as a Base

What are the advantages an Indian firm has in meeting these needs of developing countries (apart from a lower crude man-hour cost)?

a. Location
The 'home office' will be much closer to the scene of the action.

b. Environmental Compatibility
Indian engineers and systems people will understand the working environment and the living environment much better than their peers from East or West. They are also less likely to regard being stationed in a developing country as a hardship, and will therefore be more effective workers on site.

c. Education
It will be for the reasons above, much easier to create and conduct an effective educational effort in UDCs by sending teams from the home office.

d. Systems Support
Similarly a software support guarantee which will assure the users against future system failures will cost much less to provide over a long period.

The disadvantages of an Indian firm relate entirely to the hardware aspects especially those that might involve clearance of materials through Indian customs. It will be shown below that UDCs require complete systems service including hardware, and therefore this handicap may require very special attention, not excluding offshore warehousing of back up systems.

3. Needs of the Market

From the discussion in Section (1) we can distinguish two parts to the market - (a) that which exists and where top decision makers in a UDC know broadly what they need and are actively searching for suppliers or alternates, and (b) that which is latent at present and needs development - promotion or education as the case may be to become real.

Typical examples of (a) are Indonesian and Middle Eastern Oil Companies, Singapore banks, and many U.N. - aided projects. Typical examples of (b) are the Universities, tax authorities and import-export boards, Trade Authority, Free Port and banking as well as governments with an extractive natural-resource base. Less developed UDCs such as Nepal, Afghanistan (one computer each) also fall into category (b), as do Sikkim, Bhutan, Ceylon and much of East Africa.

The examples above also indicate the range of the market from conventional E.D.P. to real-time. And the variety of the technological environment. Singapore, for example, is a free port and several computer companies have maintenance bases there - I.B.M., I.C.L., N.C.R., and H.P. In many other locations, however, maintenance is available only from I.B.M., thus severely restricting the flexibility of systems design and consequently raising costs considerably. Indeed, when only I.B.M. service is available, there is some question about the opportunities for a software house since I.B.M. itself provides a form of software support.

4. "Not relying on I.B.M." as a strategy

This consideration leads inevitably to the conclusion that to work in the UDCs requires a software/systems firm to go for applications where I.B.M. systems are inherently less suitable and to be able to assure total systems support on non-I.B.M. equipment. This may not be so difficult because of the relative importance of data recording and transmittal as against processing in UDCs. Where an alternative supplier, such as N.C.R., Hewlett Packard, Burroughs, I.C.L. or Seimens-CII, will provide maintenance, this is easy. Elsewhere, creating a market will require the firm to take on the characteristics on an O.E.M.

4.1 Strategic Advantages

Strategically there are some non-trivial advantages to the non-I.B.M. path which need to be considered and evaluated. These include keeping the situation fluid and less amenable to domination by the other (well established but) I.B.M.-oriented software suppliers, thereby providing the firm some leverage relative to its hardware suppliers; providing a substantial source of profits when alert technological choices are made ahead of the market (e.g. using a single microprogrammeable C.P.U. for many applications); discounts on O.E.M. prices; creating a brand image and personality for the firm, etc. On the other hand choosing to ride on the I.B.M. bandwagon does not give any identification to the firm which may be easily overshadowed by its more impressive and experienced competitors in developed countries. Such an approach can be appropriate only for a very small concern whose advantages in the UDC are solely its lower costs and possible direct personal contacts.

4.1.1 Where is IBM vulnerable?

The weak points of "fortress IBM" are insufficiently realised. In the developing countries we are familiar only with its major strong point:- hardware maintenance second to none based upon a well-established if bureaucratic system. In contrast to that advantage of its size, there are disadvantages of size too. When very large quantities of a product have to be produced, distributed, documented, trained for and supported, it is obvious that designs have to be frozen at an earlier date than would be the case if smaller quantities were involved. This results in giving IBM's smaller competitors a technological edge which could extend to several years. This reflects both in the capability of the resulting product and in the cost of manufacture, which today is a rapidly decreasing function of technology.

There is another factor too. IBM's vast volume is based not just on a few mainstream data processing applications but on all kinds of application environments. Its software and hardware features, especially the Operating Systems, are therefore built to function in a very large variety of situations. Because they are so general-purpose, they are de-tuned or less efficient for any specific situation. They are also bulkier, to allow for options that may not

always be used, both in hardware and software. Typically an IBM system will require more core memory for a given set of tasks. This reflects in the capital as well as the running costs of the system.

Developing countries' applications are the least likely to take advantage of all the peripheral options offered; they would nevertheless have to pay for the CPU features built-in to provide this flexibility. This is a factor in other manufacturers' prices as well as IBM's: even here some are more incrementally priced than others.

Finally, because of the overhead costs and the diseconomies involved in handling large numbers of low-unit-value minicomputer sales, IBM has not built up its strength in this field. But minicomputers offer many technical advantages, in addition to a radically lower cost, to UDCs.

The technical advantages include the ability to utilise a wide variety of peripheral devices of large as well as small capacity. The possibility also of modular hardware growth in easy steps is really a managerial advantage because of the opportunity to develop effective management capability in stages before further increases in hardware capability and the consequent fixed investment. With large systems there is invariably a long time between installation and full, or even satisfactory, utilization because of the difficulties of learning to manage the new technology.

4.2 Education/Training and Facilities Management

Several streams of thought on the issues involved in Software export therefore cluster around the non-I.B.M. path. This in turn is complemented by an idenpendent education/training activity on information technology and informatics which enables the firm to break in to new markets. Also complementary is a facilities management service, providing E.D.P. support services on a fixed term contract. Since most installations expand as time goes by, they open up new systems prospects, and the insider already has a great if not overwhelming advantage. Finally, in the integration of hardware, communications and software comes the opportunity for work on both conventional electronic interfaces and on microprogrammed firmware.

Supportive of this strategy is a plan which will maintain a physical presence on the ground on a semi-permanent basis in or close to the major markets, in Singapore, Hong Kong, Djakarta, Kuala Lumpur, Beirut, Teheran and Nairobi, and on a project basis in other locations. Continuity and repeated personal contact and a detailed knowledge of the potential customers' problems are essential in the computer business, as is well known. We have mentioned above that many current needs for informatics occur on the interface between the developing country and the developed world, including the U.N. agencies, the I.B.R.D., I.M.F. and A.D.B. Keeping track of these possibilities is also necessary on a continuing basis. The rotation home of a total of six to ten representatives and of project teams of 3 to 5 each does raise a question regarding the size of the home office and of projects at home.

5. Need for a Home Market

In the competitive and ruthless international market where payment is made convertible currencies, no consideration will be given to an agency which cannot point to significant technical achievements in its home market*. Besides India has all the same needs, and often for the same reason, as other UDCs and, indeed, is the recipient of considerable foreign exchange for projects which are presently suffering for lack of information services. Typical examples are the Rajasthan Canal Project; construction and management of other major hydro and irrigation schemes, the shipyards, and steel plants; the airlines and the aircraft industry, etc. Apart from these management-of-capital-resources applications, there are important, very large, and potentially sophisticated, real-time logistic systems now technologically feasible in Food, Fertilizers, Fuel and Steel distribution and in the transportation sector,(G); (H) substantial foreign exchange savings are possible in every case through use of modern information technology in well designed Management Information Systems.

Having established the existence of many urgent information system problems in India, we need to consider how working on them will complement and support work on systems and software for export.

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*E.g. The uncertain fate of the U.S.S.R's SERENA airline reservation system has seriously damaged its credibility about sophisticated computer systems.

The critical issues are the competitiveness and the arbitrariness, both in scope and time, of the export market. Any firm working fully in this difficult arena would have a most difficult scheduling task on its hands, not to mention the concommitant morale problems and the difficulty of arranging an orderly internal training and human resource development activity. It is therefore essential that a relatively stable domestic market be built up, considerably bigger in size than the export activity, and capable therefore of absorbing the fluctuations and pressures of the international market. A ratio of 1 to 4 between manyears of export and manyears of domestic work seems to be the order of magnitude required.

This would seem to imply that the export market be developed on a consortium basis, involving a number of home-based software houses. The software and informatics consultant business in India is still quite small - a total of perhaps 150 professionals(I) - compared for example with 5,800 consultants, analysts and programmers in France or even with 4,700 in the U.K. with billings of $98 million and $43 million respectively, according to a recent survey(J). There are large numbers of Indian computer scientists employed abroad, however, and even the trickle of returnees has already created a startling rate of growth of software and consulting companies. The Export market cannot however be seriously penetrated by such small operators. The risks involved and the variety of talents needed seem to point inevitably to a corporate consortium arrangement whereby the members retain their individual identity in the home market but operate under a common banner overseas.

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